SILVER BOW CREEK INVESTIGATION

RESPONSE TO REVIEW COMMENTS RECEIVED FROM

ANACONDA MINERALS COMPANY:

SILVER BOW CREEK PHASE I REMEDIAL INVESTIGATION

CH2M HILL

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INTRODUCTION

This document responds to comments received by the Montana Department of Health and Environmental Sciences (MDHES), Solid and Hazardous Waste Bureau, from Anaconda Minerals Company (AMC) regarding the Silver Bow Creek Remedial Investigation (RI) Phase I conducted pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP). This RI was conducted to characterize a very large Superfund site, identify operable units within the site, and prioritize further investigative and remedial activities at the numerous operable units at the site. Consistent with the NCP and EPA guidance, additional remedial investigative work at the site has been conducted, is in progress, or is planned. The RI was produced by MultiTech, Inc. for MDHES in 1987. CH2M HILL assisted the State in responding to AMC's comments.

In this document, the State responds to legitimate concerns and issues raised by AMC in its comments to the Phase I RI, clarifies and supplements Phase I RI statements that need supplementation of clarification, and corrects any Phase I RI information that has since proven to be incorrect.

The format of responses contained in this document is consistent with the format used by AMC in generating its comments on the Phase I RI. AMC comments are reproduced in their entirety; responses to general comments follow each paragraph of AMC's general comments and responses to specific comments follow specific comments raised by AMC. Where appropriate, supporting information is included as attachments at the end of each major section and referenced in the text.

SURFACE WATER AND POINT SOURCE INVESTIGATION
(APPENDIX A, PART 1)

OVERVIEW

The Surface Water and Point Source Investigation is part of the Silver Bow Creek RI report, which was submitted by MultiTech to the Montana Department of Health and Environmental Sciences in April 1987. The study was conducted to determine the extent and severity of contamination in Silver Bow Creek and the Upper Clark Fork River, and to generate the information needed to evaluate remedial alternatives. The surface water investigation had the following specific objectives:

- o Determine the spatial and temporal variations in surface water quality and quantity
- o Determine the most impacted stream reaches and the sources or mechanisms within them causing water quality degradation
- o Determine how streamwater quality changes during major precipitation runoff events
- o Determine how streamwater quality changes in response to groundwater discharges.

The investigation included a 9-month field sampling program conducted from December 1984 through August 1985. The analyses focused on six metals: (arsenic, cadmium, copper, iron, lead, and zinc). During this period, water samples were collected on 15 separate occasions from 21 stations on Silver Bow Creek in the 26.5-mile reach between Butte and the Warm Springs Ponds. Samples were also collected from major point sources and tributaries to this upper reach of the creek and from the Warm Springs Ponds system. During the two summer baseflow sampling events (22 July 1985 and 28 August 1985), 20 additional stations on Silver Bow Creek were

sampled to help identify groundwater inflow and to account for losses due to irrigation withdrawals. Samples were also collected from seven stations on the Upper Clark Fork River between Warm Springs and a point above the confluence with the Little Blackfoot River on two of the sampling events (22 May 1985 and 18 June 1985). In addition to the 15 sampling events described above, a special sampling program with a limited number of sampling stations was conducted on 29 May 1985 to characterize sources and discharges in upper Silver Bow Creek during a rainfall runoff event. For this storm event, only four stations on Silver Bow Creek (SS-02, SS-03, SS-04, SS-07), and seven point sources discharging to the river between Station SS-02 and SS-07, were sampled.

The following general comments were submitted by AMC and concern the analysis of the data and the report as a whole. Specific comments address individual items on specific pages of the report. Comments by AMC focus on the analysis of the data generated during the RI, and do not address the review of historical data that was presented in the report.

GENERAL COMMENTS BY AMC

The Surface Water and Point Source Investigation Report quantifies contaminant loadings from individual sources, but does not evaluate Silver Bow Creek as a continuous stream system, by presenting a clear picture of the spatial trends in water quality in Silver Bow Creek, or assessing the relative effects of individual sources. The stream is divided into segments with each segment analyzed independently. Although the sampling techniques used in the study were designed to yield synoptic data for the entire creek between Butte and Warm Springs, the analysis does not take advantage of these synoptic data sets. Source loading data from all stream segments should be compared on an equivalent basis to determine the relative importance of individual sources. In addition, the spatial trends in water quality and contaminant loading conditions should be evaluated to detect changes in the transport of contaminants through the river system.

The evaluation of potential contaminant sources in the Silver Bow Creek study area was based on average loadings calculated from various combinations of individual data sets. Average loadings were generally calculated for two streamflow conditions (i.e., high flow and low flow). However, only the average loading values are presented in the RI report. Consequently, it is not possible to determine the overall range and variability in contaminant contribution from each source. Because loading is dependent on a variety of factors, it is likely that contaminant loading is highly variable over time. Therefore, an average loading value, particularly one based on only three to four data points, may not be meaningful.

Different data sets were used to calculate average loadings from each source, making it impossible to compare contaminant loadings from source to source. For example, the average high-flow loading from Missoula Gulch (PS-04) was calculated using data sets 6-8 (11 March 1985, 25 March 1985, and 8 April 1985), while the high-flow loading from the Silver Lake discharge (PS-11) was calculated using data sets 1, 2, 3, and 10 (3 December 1984, 26 December 1984, 28 January 1985, and 6 May 1985).

The effect of the source loading on Silver Bow Creek was evaluated based on the ratio of loading from the individual source to that from all upstream sources. This technique tends to be biased in that sources in upper Silver Bow Creek, where there is less flow, are weighted more heavily than sources in the lower reaches of the creek. For example, the Metro Storm Drain (SS-03) was found to contribute 97.1 percent of the high-flow zinc loading (total zinc) in Silver Bow Creek (as measured at the confluence with Blacktail Creek). For comparison, the Butte wastewater treatment plant (when groundwater pumped from beneath the plant was included in the effluent) contributed 82.6 percent of the zinc loading in Silver Bow Creek (as measured at Station SS-06). However, the actual zinc loading in the plant effluent was 279.9 lb/day compared with only 47 lb/day in the Metro Storm Drain.

In many cases insufficient data are provided to support statements made in the RI report (see Specific Comments). Because supporting information is not provided, it is not possible to reproduce the values calculated in many of the source loading tables. Sufficient data must be provided to justify the conclusions. A clear understanding of the relative metals loading inputs to Silver Bow Creek and the transport processes within the river is needed to evaluate remedial alternative options.

Response: Data that were collected during the surface water and point source investigation can be analyzed from a number of perspectives and using a variety of techniques, including analyzing the data with respect to time, space, sources, and instream flow conditions. The Phase I RI report focused on flow relationships; however, if it is necessary, additional analysis of the same data can be performed during subsequent feasibility studies. Further, because ARARs for the Silver Bow Creek CERCLA site are at least in part dependent upon metals concentrations in the stream in any given reach, it is necessary to evaluate each segment of the stream to determine if ARARs will be met.

All of the data produced during the Phase I RI are presented in an attachment to the RI report. If the range of values of any given parameter is of interest, it can be determined from data provided in the attachment. Hydrologic systems are highly variable, and the range of natural conditions that were sampled in 1985 (a dry, low-flow year) are probably not the entire range of values that can be expected for the Silver Bow Creek system. How looking at a limited range of values, instead of evaluating averages, is going to better define the nature and extent of contamination within the system is unclear.

The object of looking at the different sources contributing to Silver Bow Creek is to determine their individual impact on the receiving stream where they enter the stream, not solely to compare them to

each other, or to address their individual effect upon the total system. Again, a valid purpose of looking at each source is to determine its impact on the stream at that point.

Specific comments are addressed in the following text. The purpose of the RI is to provide data necessary to determine the nature and extent of site contamination and to provide data necessary to evaluate remedial alternatives in subsequent feasibility studies. The Phase I RI provides data that were perceived to be necessary at the time the investigation was initiated. Any additional data needs that were not met during the Phase I RI, or that have become evident since completion of the Phase I RI, can and will be filled during Phase II RI efforts.

SPECIFIC COMMENTS BY AMC

1. Page 3-24: The 29 May 1985 storm runoff data are not included in the storm category. Data from this event were used to calculate high-flow loadings for several of the point sources, and to evaluate bank and channel erosion, but the data are not presented anywhere in the RI report. Metals concentrations are shown in the data summary in Appendix A, Part 2, but no flow data are presented with which to calculate contaminant loadings. This information should be provided in the report. In addition, it is unclear whether or not the metals concentrations represent flow-weighted averages.

   Response: The event of May 29th was sampled during actual runoff conditions in Butte and was sampled in a manner different than routine surface water samples. One sample was analyzed for each station as explained in Section 2.2.5. Data used to produce the flow composited samples are presented in Attachment A-1 to this response document.

2. Page 3-28, Table 3-12: The reason for using a varying number of sampling runs to calculate average gains in flow from unaccounted sources under high-flow and low-flow conditions needs to be explained. Also, the sampling runs used in the calculations should be identified. For example, only three data sets were used to calculate average low-flow gains in the reach between Stations SS-05 and SS-06. However, six data sets were used to calculate flow gains in the adjacent reach between Stations SS-06 and SS-07. The analysis should be consistent in its use of the data. In addition, ranges in flow gains, as well as average values, should be presented.

Response: Table 3-29 in Attachment A-2 of this response document contains the percent flow gains between all sampling stations during all Silver Bow Creek sampling runs. In most cases, gains were calculated using sampling runs that demonstrated a clearly identifiable "low flow" or "high flow" period. True, high flow and low flow are defined for a specific period, but use of the modifiers, high and low, is not an indication of absolute values. The period during which all flows and samples were analyzed (1985) was a relatively dry, low-flow period, but streamflows that were measured were divided into high and low flow events. Nonetheless, efforts were made to include the same runs in all calculations, as shown in the following table.

	SAMPLE RUN NUMBER	
Stream Section	Low Flow	High Flow
SS-05 to SS-08	4, 14, 15	7, 8, 9, 10, 12
SS-06 to SS-07	3, 4, 5, 13, 14, 15	7, 8, 9, 10, 12
SS-08 to SS-09	2 , 3, 4, 5, 13, 14, 15	7, 8, 9, 10, 12
SS-09 to SS-10	4, 5, 13, 14, 15	7, 8, 9, 10, 12
SS-10 to SS-11	13, 14, 15	8, 10, 12
SS-11 to SS-13	13, 15	7, 8, 9, 10, 12

Caution must be used when comparing these calculations. Duplicate measurements were averaged. Also, in the area between SS-09 and SS-11, sampling was not completed on the same day. Run 7 and subsequent sampling runs included a flow measurement at the upstream station of the previous day so that gains or losses could be determined. Prior to run 7, this was not done; hence, fewer runs were used for calculations between S-10 and SS-11.

Ranges of flow gains may be calculated from the raw data. The point made in the text is that these are gaining reaches of Silver Bow Creek. A greater amount of detail does not alter the conclusion.

3. Page 3-35, Table 3-14: The 29 May 1985 data indicate that the Walnut Street (PS-0A) and Warren Avenue (PS-01) storm drains contribute relatively little metals loading to the Metro Storm Drain (MSD) compared with that from the Harrison Avenue drain (PS-02) and that from unaccounted sources. Drainage basin area and a description of the physical and land use characteristics of the drainage basin should be included to aid in the evaluations of loading contributions from these storm drains. For example, the Harrison Avenue storm drain would be expected to contribute relatively higher metals loadings to Silver Bow Creek than the Walnut Street drain because the former serves sections of uptown Butte that is underlain by a known ore body and has been affected by past mining activities. The Walnut Street drain serves an area outside the mining district on the south side of the Metro Storm Drain that is underlain by alluvium. Further discussion of land use characteristics in each drainage basin would aid in the identification of potential sources and would help focus any additional work on specific problem areas.

   Response: The work on land use is currently being performed by EPA.

4. Page 3-37, Table 3-15: Because the actual storm drain loadings (in lb/day) are not shown in this table, it is impossible to compare loadings for storm drains in Table 3-15 with those presented in Table 3-14. The evaluations of load contributions for the storm drains

shown in both Tables 3-14 and 3-15 are based on data from the 29 May 1985 storm runoff event. However, because the percent contributions for the sources in each table were calculated relative to different stations on Silver Bow Creek, it is impossible to compare the sources in one table with those in the other. Either the actual contaminant loading values (in lb/day) should be included in the tables or the percent contributions (percentage values given in Tables 3-14 and 3-15) should be calculated relative to the same station in Silver Bow Creek.

Response: Contaminant loads contributed to the Metro Storm Drain and Silver Bow Creek by the May 29, 1985 storm runoff event in the Butte area are presented in Attachment A-1 of this response document. These contaminant loads are calculated by multiplying the weighted discharge values for each station sampled during the storm runoff event (also in Attachment A-1) by the analytical data for each composited water quality sample collected at each sampling station. Storm runoff data, and total copper and zinc loads, by contributing point source, are also shown graphically in six figures also contained in Attachment A-1 of this response document.

Data presented in Attachment A-1 of this response document are further confirmation that the storm runoff event on May 29, 1985 contributed higher than normal contaminant loads to the Metro Storm Drain and Silver Bow Creek.

5. Page 3-38, Table 3-16: Why were the 29 May 1985 storm runoff data not used to calculate the average high-flow loading from Missoula Gulch (PS-04)? These storm runoff data were used to evaluate bank and channel erosion contributions (see Table 3-25, page 3-53). The report should be consistent in the use of the data to calculate "average" loadings.

Response: The May 29th sampling event was the only storm runoff sampling conducted, and therefore sampled a very different condition

than the "high-flow" events which measured the more typical high flows of spring runoff. The reference to the storm runoff episode of May 29th in the last sentence of page 3-52 should be corrected. This sampling event did not extend below SS-07 and was not used to calculate the values in Table 3-25. The correct reference on page 3-52 should be to the May 20 sampling episode.

6. Page 3-38: Further explanation is needed concerning groundwater pumping at the Butte wastewater treatment plant. For instance, how often is groundwater pumping required? Is pumping required as standard operating procedures at the plant or is it done only periodically? The frequency and duration of groundwater pumping will determine the significance of its effects on Silver Bow Creek. If groundwater pumping occurs infrequently, it may have little overall effect on Silver Bow Creek compared with the constant daily loading from the plant effluent.

   <u>Response</u>: Pumping is performed only when clarifiers or tanks need cleaning, and occurs only three to four times a year. Because groundwater levels are close to the ground surface at the treatment plant, when the clarifiers or tanks are emptied for cleaning, groundwater levels must be lowered by pumping to keep the clarifiers and tanks from being damaged. Although the total load of metals delivered annually by this pumping is small compared to other sources of metals in Silver Bow Creek, metals concentrations in the discharge create higher metals concentrations in the stream than typically occur and exacerbate existing degraded stream water quality conditions.

7. Page 3-41: The statement "...metals loadings from PS-10 proved to be insignificant..." needs to be supported with actual loading data, and the term "insignificant" should be statistically quantified.

   <u>Response</u>: The following table summarizes the calculation of percent load of metals at PS-10 as compared to SS-11.

METALS LOADS AT PS-10 AND SS-11
ON AUGUST 28, 1985

Parameter	PS-10 Concentration (mg/L)	PS-10 Load (lb/day)	SS-11 Concentration (mg/L)	SS-11 Load (lb/day)	Percent PS-10 Load of SS-11 Load
Cu Total	<0.009	<0.003	0.183	21.2	<0.01%
Cu Dissolved	<0.019	<0.006	0.061	7.07	<0.08%
Zn Total	0.009	0.003	0.751	87.0	0.003%
Zn Dissolved	<0.010	<0.003	0.511	59.2	<0.005%

8. Page 3-46: The discussion of groundwater inflow should emphasize that groundwater contributes primarily dissolved metals to Silver Bow Creek and that sections of the river that are influenced by groundwater can be identified based on changes in the dissolved vs. total metals transported by the river. For example, review of the two summer low-flow data sets (22 July and 29 August 1985) indicates that percentage of metals loading in the river transported in the dissolved phase increases significantly near the Butte Reduction Works and the Colorado tailings.

The discharge of contaminated groundwater from these two areas increased the dissolved zinc concentrations in Silver Bow Creek by as much as 390 percent between Stations SS-05 and SS-07 (downstream of these sources). Downstream of Station SS-07, dissolved zinc concentrations declined dramatically as dissolved zinc was transformed to solid-phase zinc (Figure 1). Copper concentrations exhibited a similar trend. On 22 July 1985, dissolved copper concentrations increased from 27 percent of the total copper at Station SS-05 to 51 percent of the total at Station SS-07. Downstream of Station SS-07, the dissolved copper concentration decreased to about 30 percent of the total as copper was partitioned between dissolved and solid phases. This same pattern was evident in the 29 August 1985 data.

Response: This comment makes an important point which is consistent with conclusions in the document, as well as substantiates that the Phase I RI has provided data necessary to determine the nature and extent of contamination in Silver Bow Creek. As stated elsewhere in the Phase I RI report, the Metro Storm Drain area, the area around the Butte Reduction Works, and the Colorado Tailings area, are all major sources of degraded groundwater inflow.

9. Page 3-48, Table 3-21: The data used to calculate average low-flow loadings attributable to groundwater inflow between Station SS-02 and SS-03, shown in Table 3-21, must be identified. The dates appear to be from 26 December 1984, 29 January 1985, 11 February 1985, 22 July 1985, and 27 August 1985 (see top of page 3-25). However, three different data sets (3 December 1984, 3 June 1985, and 22 July 1985) were used to calculate the average low-flow loadings from the Metro Storm Drain (MSD) (SS-03) (see Table 3-13 on page 3-34). The report should be consistent in its use of the sampling data to define average loading conditions.

   In addition, the average low-flow copper, zinc, and iron loadings presented in Table 3-21 cannot be reproduced using the low-flow values summarized in Table 3-27:

SS-02 to SS-03	Table 3-21 (lb/day)	Calculated From Table 3-27 (lb/day)
Cu (Total)	1.8	7.1
Fe (Total)	8.6	36.1
Zn (Total)	22.9	29.7

   Response: Table 3-21 demonstrates loads to the MSD attributable to groundwater input. Table 3-13 is a summary of average total loads to SBC from the storm drain. These loads should be (and are) quite similar.

Again, loads on Table 3-21 are gains attributable to groundwater inputs, while Table 3-27 are average loads at a given station, which are not necessarily the same.

10. Page 3-49, Table 3-22: The data used to calculate the average values presented in Table 3-22 must be identified. In addition, it is not clear if the loading contribution from the Butte wastewater treatment plant is included as part of the loading gained between Stations SS-06 and SS-07. Loadings from the plant and any other point sources should not be included when evaluating contributions from groundwater inflow. The title of Table 3-22 should be revised to emphasize that loading gains are from groundwater flow.

    Response: Attachment A-2 to this response document contains tables showing the percent load increases for all runs with the point source contributions subtracted. Review of these data substantiates the gains shown in Table 3-22 of the Phase I RI report and the conclusion that groundwater inflows of degraded quality are the cause of these gains.

11. Page 3-51: Metals concentration data from Well DW-130 should be included in the text to support the statement that groundwater on the north side of Silver Bow Creek near the Colorado Tailings exhibits "...much lower metals concentrations."

    The discussion of metals loadings for groundwater inflow to Silver Bow Creek in the reach between Stations SS-06 and SS-07 addresses contributions from only the Colorado Tailings area located on the south side of the creek. However, data presented in Table 3-17 (page 3-39) and in the groundwater report (MultiTech 1987a) indicate that groundwater inflow from the north side of Silver Bow Creek is also a source of loadings, particularly copper and zinc. Loadings in the effluent discharged from the Butte wastewater treatment plant (PS-08) were significantly higher when groundwater pumped from wells at the plant was discharged in the effluent. The groundwater

contaminant plume apparently originates from the Butte Reduction Works and extends along the north side of Silver Bow Creek (see Groundwater Investigation Report, MultiTech 1987a). Therefore, the discussion of nonpoint source loading to Silver Bow Creek should be changed to show that groundwater inflow from both the Colorado Tailings and the Butte Reduction Works areas contributes metals loading to Silver Bow Creek between Stations SS-06 and SS-07.

In addition, the mass balance technique that was used to estimate metals loadings from groundwater inflow to Silver Bow Creek fails to take into account the loss of metals due to deposition.

Consequently, the groundwater loadings that were reported in the RI may be underestimated. For example, on 22 July 1985, the total suspended solids concentrations in Silver Bow Creek decreased by a factor of two between Stations SS-06 and SS-07, which indicates a depositional environment in this reach of the creek. Because 48 percent of the total copper in the reach is associated with the suspended solids, copper must also be deposited. The total and dissolved copper concentrations increased by 17 percent and 22 percent, respectively, between Stations SS-06 and SS-07. To maintain a mass balance of copper in this reach, the amount of copper contributed by groundwater must account for both the gain in copper loading observed across the reach and the loss of copper due to deposition. The mass balance analysis does not take into account the depositional loss of copper. Hydrological Simulation Program-Fortran (HSPF) (Johnson et al. 1984) was used by Tetra Tech to model metals transport in Silver Bow Creek based on the low flow conditions of 22 July 1985. The results showed that an additional 1.5 lb/day of copper, above the amount predicted by the mass balance analysis, had to be added in this reach (between Station SS-06 and SS-07) to calibrate the model output to the observed copper concentrations at Station SS-07. This extra copper loading probably represents the amount of copper that settled out of the water column in this reach.

Response: Groundwater quality data for the Butte sewage treatment plant area indicate that the area below Station SS-06 is contaminated, and the most logical source is the former Butte Reduction Works. The analysis of deposition between SS-06 and SS-07 may be correct and makes a good argument for even greater metal inflows in this reach. Additional quantification of groundwater movement in this area is planned.

12. Page 3-52: It is not clear how data from the 29 May 1985 sampling run can be used to calculate average loading gains attributed to bank and channel sediment erosion in the reaches between Stations SS-07 and SS-10, and between SS-13 and SS-16, when Stations SS-10, SS-13, and SS-16 were not sampled on that date. Because three of the four stations bracketing these two reaches on Silver Bow Creek were not sampled on 29 May 1985, those data cannot be used to evaluate loading gains from bank and channel erosion. The loading gains should be recalculated using only the high-flow data sets where all four stations (SS-07, SS-10, SS-13, and SS-16) were sampled and the text should be revised accordingly.

    Response: As previously indicated, the reference to the May 29 sampling event on page 3-52 is incorrect. The appropriate sampling episode indicated on page 3-52 began on May 20, 1985.

13. Page 3-52: Total suspended solids data should be presented to support the statement that bank and channel sediment entrainment contributes solid-phase metals loadings to Silver Bow Creek in the reach between SS-07 and SS-10 and that between SS-13 and SS-16. If solid-phase metal loading increases from bank and channel erosion, total suspended solids loadings should also increase.

    Response: Total suspended solids loading changes for each run are presented in Attachment A-2 of this response document. As shown in this attachment, total suspended solids loads routinely increased between these sampling sites throughout the study period.

14. Page 3-53, Table 3-25: It is unclear how the loading values presented in Table 3-25 were derived. An attempt was made to reproduce these loadings attributed to bank and channel sediment entrainment by using the average high-flow loading values summarized in Table 3-27. Significant differences were obtained for the zinc and iron loading values:

	Fe (lb/day)		Zn (lb/day)	
	Table 3-25	Table 3-27	Loadings Calculated From Table 3-25	Loadings Calculated From Table 3-27
SS-07 to SS-10	154.7	55	25.2	4.4
SS-13 to SS-16	132	132	26.5	-3.9

Sample calculation for reach SS-07 to SS-10:

Fe = Increase in solid Fe loading - Loss in dissolved Fe loading

$$(314.6 - 251.1) - (25.1 - 16.6) = 55$$

Response: These numbers presented in Table 3-25 were derived from the raw data, not the summary data in Table 3-27. Each run was evaluated separately and the gains averaged. The method provides an estimate because many physical and chemical changes are occurring. The calculation was used only to present an order-of-magnitude estimate of contributions from this source so it could be compared with other sources.

15. Page 3-54: Correlation coefficients should be provided to support the statement, "In general, very good correlations are observed..."

Response: The statement is a generalized one. The calculated correlation coefficients range from 0.50 to 0.95 for the groupings stated in the text. These correlations can be calculated from the raw data. The object was to point out relationships between analytes to allow development of theories of transport phenomena.

16. Page 3-55: The discussion of copper precipitation is inconsistent. The report states (middle of page 3-55) that copper precipitation is favored in Silver Bow Creek downstream of Station SS-07. This conclusion is apparently based on the copper solubility diagram shown in Figure 2-4 (see page 2-34). However, in the following paragraph, it is concluded that solid-phase copper is formed primarily by adsorption onto suspended sediments and iron precipitates. This discussion needs to be clarified.

In addition, the description of low-flow copper and zinc precipitation in Silver Bow Creek presented in the report does not agree with results obtained by Tetra Tech using MINTEQ. MINTEQ (Felmy et al. 1983) is a geochemical and equilibrium program that was used by Tetra Tech during this review to evaluate the potential for precipitation of dissolved copper and zinc in Silver Bow Creek. The available data indicate that pH generally increases from the head to the mouth of Silver Bow Creek. To simulate the effects of increasing pH along the length of Silver Bow Creek, metals concentrations data from Station SS-04 (where measured pH was 7.6) were input to the program, and pH was adjusted to the level observed in lower Silver Bow Creek at Station SS-17 (pH 9.6). Because metal solubility typically decreases as pH increases and pH was fixed artificially high, this approach, although only a rough approximation, should favor the formation of metal precipitates and is a conservative approach to evaluating the potential for metals precipitation in Silver Bow Creek.

At equilibrium, copper precipitation was not predicted using MINTEQ. Therefore, under actual field conditions, which are less favorable to the precipitation of copper than modeled, it is unlikely that copper would precipitate out of solution in Silver Bow Creek as described in the RI report.

The precipitation of zinc as zinc silicate was predicted by MINTEQ using this same approach. Because silica concentrations were not measured in Silver Bow Creek during the RI, a range of silica concentrations was input to MINTEQ. Silica concentrations of 0.6, 6, and 15 mg/L were input to determine the sensitivity of the zinc precipitate to dissolved silica concentrations in the river. The two higher values represent the range of silica concentrations present in most natural waters. Zinc silicate precipitate was formed at both the higher silica levels. The lowest silica value (0.6 mg/L) was input as a check. Zinc did not precipitate at this lowest silica concentration. These results are not in agreement with the conclusions stated in the RI report. The most likely reason for this discrepancy is that the zinc solubility analysis presented in the report did not take into account the formation of zinc silicates.

Response: As suggested in the text, there are at least two apparent processes that are occurring along Silver Bow Creek that reduce the dissolved metal load: precipitation and adsorption. Both are functions of pH and complex interactions with other dissolved and solid organic and inorganic species (ions, compounds, minerals, and biota). There are also many unknowns. Some of the unknowns could be rectified with more sampling and testing, but it would not change the general conclusion stated in the report that precipitation of metals is occurring in reaches of Silver Bow Creek.

As stated in AMC's Comment No. 8, measured dissolved copper concentrations decreased in the downstream direction along Silver Bow Creek during both the July and August 1985 sampling episodes. These data are contrary to the point that Tetra Tech is apparently attempting to make; that copper precipitation is unlikely in Silver Bow Creek. These data further indicate that the MINTEQ model likewise does not work properly for conditions actually measured in Silver Bow Creek. Therefore, some assumptions inherent in the model must be incorrect.

Results from thermodynamic equilibrium models like MINTEQ, WATEQ, and PHREEQE are only as good as the model assumptions, model thermodynamic constants, and the data input. Interpretation of model results is essentially a test of these three factors and really expresses tendency to either precipitate or dissolve a list of simple compounds or minerals. Organics, kinetics, and adsorption are not considered. Even if the model predicts that a particular dissolved metal concentration is being controlled by a particular compound or mineral on that list, the prediction is typically based on a relatively simple calculation that does not describe even the major process(es) interacting within the dynamic surface water system. For the Phase I RI report, it is believed that general processes can be hypothesized because they are ubiquitous. Evaluations of specific reactions were beyond the scope of work for the Phase I RI.

17. Page 3-56, Figure 3-4: It is not clear how Figure 3-4 was generated. It appears to have been derived from the average loading data summarized in Table 3-27. As has already been explained, generalizations based on average values can be misleading. Further discussion is needed in the text to explain how the conclusions in Table 3-4 were drawn and to describe the variability of the data used in the analysis. With this information, the limitations in the conclusion discussed in Figure 3-4 can be clearly identified. Representative stream profiles (see Figure 1) of metals concentrations and loadings showing spatial trends in water quality conditions and illustrating transport mechanisms should be included in the report to help justify the conclusions drawn in Figure 3-4.

    In several instances the transport mechanisms presented in Figure 3-4 are not justified based on the data presented (see Table 3-27). For example, Figure 3-4 indicates that under low-flow conditions, sedimentation of solid phase copper occurs in the section of river between Stations SS-07 and SS-08. However, the data summarized in Table 3-27 show that both total suspended solids and solid phase copper loadings increase in this reach which suggests that sedimentation is not occurring in this reach.

Under low-flow conditions, Figure 3-4 also indicates that zinc sedimentation occurs in the reach between Stations SS-04 and SS-07. However, examination of individual data sets from 26 December, 28 January, 11 February, 22 July, and 28 August showed that zinc concentrations did not exhibit a consistent pattern under low-flow conditions. A mass balance on solid phase zinc loading across upper Silver Bow Creek shows that solid phase zinc loading increased rather than decreased between Stations SS-06 and SS-08 on two of the three winter baseflow sampling events. In addition, very little zinc was transported in upper Silver Bow Creek (less than 20 percent) in the solid phase under winter baseflow conditions. Under summer baseflow conditions, zinc was transported entirely in the dissolved phase in upper Silver Bow Creek. Therefore, sedimentation of zinc does not appear to be an important factor in controlling the transport of zinc through upper Silver Bow Creek.

Response: Attachment A-3 to this response document presents figures exhibiting total copper and zinc loads between stations SS-02 and SS-07 on July 22, 1985. Dissolved copper loads increased significantly between Stations SS-05 and SS-07. Dissolved copper inputs to the stream represent degraded groundwater discharge to the stream over this reach, which is the same summary conclusion depicted in Figure 3-4 of the Phase I RI report.

Dissolved zinc loads also increased significantly over the stream reach between Stations SS-02 and SS-07. The near-continuous increase in dissolved zinc load begins higher in the reach than does the gain in dissolved copper loads, which is indicative of the degraded groundwater inputs along the Metro Storm Drain. As with copper loads, however, zinc loads increase appreciably between Stations SS-05 and SS-07. Again, this is the same summary conclusion demonstrated on Figure 3-4 of the Phase I RI report.

It is also apparent from evaluation of the figures in Attachment A-3 of this response document that zinc reacts by means of adsorption and/or precipitation more quickly than does copper. This is likewise in accordance with the summary conclusions indicated on Figure 3-4.

As explained elsewhere in this response document and in the Phase I RI report, identification of contaminant inputs to Silver Bow Creek are more certain than are analyses regarding contaminant geochemical dynamics within the stream, or evaluations of sediment entrainment and deposition. In the case of the former, this is because of the complexity associated with geochemical transformations in the environment, as well as the substantial number of unknowns. In the case of the latter, the scope of work carried out during the Phase I RI was not designed for a detailed examination of sediment entrainment and depositional characteristics. Consequently, conclusions depicted on Figure 3-4 are necessarily less certain than those related to groundwater discharge of contaminants to the stream.

18. Page 3-57: Total suspended solids data should be included in the report to support the statement that "Settling during low flows is observed..." Because certain metals, particularly lead, copper, and arsenic, are transported in the solid phase, information on sediment carrying capacity of individual sections of the river would be helpful to understand metals transport. Hydraulic gradient information should be provided for critical sections of the river.

<u>Response</u>: Attachment A-4 to this response document shows the hydraulic gradient of Silver Bow Creek. Based upon fundamental sediment transport principles, analysis of Attachment A-4 suggests that fluvial deposition is more favored between Stations SS-03 and SS-07, and between Stations SS-10 and SS-14, where the stream's hydraulic gradient is flattest. This simple analysis compares

favorably for zinc solids data summarized on Figure 3-4 in the Phase I RI report, although admittedly the comparison is imperfect for copper solids data shown on the same figure. Comparison of the iron solids data summarized in Figure 3-4 represents an intermediate match between the copper and zinc situations.

Comparison of Figure 3-4 in the Phase I RI report with total suspended solids (TSS) load calculations presented in Attachment A-2 of this response document also shows comparable agreement; TSS loads tend to decrease between Stations SS-03 and SS-07, and between Stations SS-10 and SS-14.

Insofar as AMC suggests that "... sediment carrying capacity of individual sections of the river ..." would be a useful analysis to allow better understanding of metals transport within and by Silver Bow Creek, this is well beyond the original scope of work for the Phase I RI. Nonetheless, nothing in the above elaboration differs from the original Phase I RI report conclusion that, "Settling during low flows is observed ...".

19. Page 4-6, Table 4-3. The final ranking of individual sources based on total loading contributed during the entire study period is not consistent with the analyses in the rest of the RI report. Previous evaluations of loading contributions were calculated separately for high-flow and low-flow conditions. These analyses indicate that source contributions were highly dependent on discharge. For example, under low-flow conditions, the Metro Storm Drain (Station SS-03) contributed 2-32 lb/day of total zinc to Silver Bow Creek. However, zinc loads increased to 21-62 lb/day under high-flow conditions. If separate source rankings were calculated based on low and high streamflow conditions, the Metro Storm Drain would rank as the third largest source of zinc loading under low-flow vs. high-flow. Source loading contributions significantly changes the ranking of individual sources because of changes in transport mechanisms, and therefore, may affect the determination of remedial actions.

In addition, the ranking system presented in the report for the Metro Storm Drain does not take into account the overall effects on water quality in the receiving stream (i.e., Silver Bow Creek). An evaluation of the relative impacts of individual sources is needed and could possibly be accomplished by comparing the magnitude of the exceedance of water quality criteria between specific sections of the river. The Silver Lake discharge (PS-11) provides a good example of the short-comings of a ranking system based only on loading. Because the effects on water quality in Silver Bow Creek were not taken into account, the Silver Lake discharge was identified as a major source of lead and sulfate. However, the loading data summarized in Table 3-18 indicate that the Silver Lake discharge does not degrade water quality in Silver Bow Creek, and in fact, helps to dilute the concentrations of lead and sulfate in the river. In addition, Tables 4 and 5 indicate that lead concentrations in the Silver Lake discharge did not exceed ambient water quality at any time during the RI study. The relatively high lead and zinc loads from the discharge were caused by large volumes of water discharged (Silver Lake discharge contributes about 18-40 percent of the flow in Silver Bow Creek at its confluence).

Response: An alternative ranking of sources, including non-point sources, is presented in Attachment A-5 to this response document. The two diagrams show the load contributions of total copper and total zinc for the period March through August, 1985. Data from the preceding winter period are not included in this alternative ranking because frozen conditions at Station SS-19 (immediately above Warm Springs Ponds) at this time made data collection impossible.

This alternative ranking scheme excludes most specific point sources identified in Table 4-3 of the Phase I RI report. It is significant, however, that for both zinc and copper, degraded groundwater inputs to Silver Bow Creek in Areas I and II (which are between Stations SS-02 and SS-07, and Stations SS-08 and SS-14, respectively) remain the most significant contaminant sources for Silver Bow Creek. Under this alternative ranking scheme, sediment entrainment is not

considered; thus, there is no simple comparison between this alternative scheme and the rankings shown in Table 4-3 of the Phase I RI report. Like Table 4-3, however, the Butte sewage treatment plant is identified as a significant contributor to system degradation, especially with respect to zinc. Zinc and copper are also both identified as contaminants contributed by the Metro Storm Drain by this alternative ranking scheme, although only zinc is identified in Table 4-3 as being contributed significantly by the same point source.

Tables identifying specific exceedances of primary drinking water standards during this Phase I RI study period are included in Attachment A-5 of this response document. Additional discussion concerning how and why these exceedances may be important are included in the response to Comment No. 20, where ARARs are also addressed.

Primary drinking water standards were not exceeded in Area III (between Stations SS-15 and SS-19), or in Area IV (between Stations SS-18 and PS-12; essentially the Warm Springs Ponds area), during the Phase I RI study, except for occasional, random lead exceedances.

20. Page 4-10, Table 4-5: The summary of exceedances of water quality criteria should be expanded to include comparisons with water quality criteria for different flow conditions in Silver Bow Creek. This analysis would aid in determining whether there are seasonal and flow-varying exceedance patterns in the river. In addition, only the water quality criteria applicable to the Silver Bow Creek and upper Clark Fork systems should be used in the comparisons. Silver Bow Creek has an E classification under the Montana State Water Quality Act (Montana Department of Health and Environmental Sciences 1982). Waters classified E are not suitable for use as drinking water and have no specific metals concentration requirements. However, the upper Clark

Fork River is classified C-2 by the state and does have specific metals concentration requirements. These C-2 metals criteria should be used in the evaluations rather than the drinking water criteria because neither Silver Bow Creek nor the upper Clark Fork River are classified for use as a drinking water supply.

Response: Attachment A-5 to this response document presents primary drinking water standards exceedances that were documented in the upper Silver Bow Creek system during the Phase I RI study and the date on which they occurred. These data augment those shown in Table 4-5 of the Phase I RI report. Providing the dates on which these exceedances were observed allows consideration of seasonal variations in the exceedances.

Montana no longer has the E classification; thus, the proposal that such a standard be used as a basis for comparison of the exceedances is without merit. ARARs have been preliminary identified for the entire Silver Bow Creek CERCLA site, and are currently in the process of being developed in greater detail for several of the operable units within the site. At this time, specific ARARs that will be used as a cleanup standards for permanent site-wide remediation have not been finally selected.

21. Page 4-12: The report concludes that additional high flow and storm event sampling are needed to fully characterize loading conditions and transport processes in Silver Bow Creek and the upper Clark Fork River. These high flow conditions were not adequately characterized during the RI study because of dry weather conditions that existed during the study period which resulted in lower than normal flows in the Silver Bow Creek and Clark Fork River systems, particularly during spring runoff.

Additional high flow and storm runoff event data are presently available for Silver Bow Creek and the upper Clark Fork River from the supplemental RI (CH2M Hill 1987). A brief review of these data indicate that it could be used to supplement the high flow data presented in this report. The supplemental RI data that would be useful include:

- Two spring runoff sampling events (14-15 April 1986 and 29-30 April 1986) for Silver Bow Creek Stations SS-02 through SS-19. Flows measured during the high flow sampling events conducted during this study (25 March 1985, 8 April 1985, 22 April 1985, and 6 May 1985). Data from the supplemental RI and this study should be compared to determine whether metals loading and transport processes measured during the 1986 spring runoff are similar to those measured during the 1985 spring runoff.

- Rainfall runoff event in the Ramsay Flats area. Samples were collected during a rainfall event (16 July 1986) from Silver Bow Creek upstream and downstream of the Ramsay Flats area, Browns Gulch, and from runoff from the tailings deposit at Ramsay Flats. Total suspended solids concentrations in the samples from Browns Gulch and Ramsay Flats, discharges were approximately 2 orders of magnitude greater than the total suspended solids concentrations measured in Silver Bow Creek above Ramsay Flats, which indicates that erosion losses from these two areas may contribute significant solids metals loadings to Silver Bow Creek during storm events. This information could be used to support the conclusions drawn in Section 3.4 (Transport of Contaminants).

- Two high flow (i.e., spring runoff) sampling events in the upper Clark Fork River. During the first sampling event (20-21 May 1986) samples were collected from the Clark Fork River between Warm Springs ponds and Deer Lodge. Flow measured at Deer Lodge (332 ft^3/s). The results from the 1985 and 1986 sampling events should be compared.

During the second sampling event (30 May - 1 June 1986) samples were collected from stations SS-10 (Silver Bow Creek above Ramsay Flats) through SS-32 (Clark Fork River at Deer Lodge). Because the discharge measured at Deer Lodge was about 3 times greater than the discharge measured during both the 20-21 May 1986 and 20-22 May 1985 sampling events, this data set should be used to determine whether higher flows affect metals loading and transport processes in lower Silver Bow Creek and the upper Clark Fork River.

o Low flow and high flow bedload sediment samples from six stations on Silver Bow Creek. Metals were analyzed in the bedload samples, but grain size distribution and bedload were not quantified. As a result, these data cannot be used to quantify bedload metals transport in Silver Bow Creek. However, the data could probably be used to indicate whether eroded tailings deposits are a component of the bedload material.

o Three high flow sampling events (5 June 1986, 12 June 1986, and 26 June 1986) for Silver Bow Creek Stations SS-14 and SS-19. Flows measured during the supplemental RI are similar to the flows measured during the high flow sampling events conducted as part of this study. Therefore, these data should be used to help support the conclusions drawn in Section 3.4 (Transport).

Response: A Final Remedial Investigation Report will be prepared that will use all of the RI data generated on Silver Bow Creek. All of the data mentioned above are being used in the ongoing RI/FS process.

FIGURE 3–20

Total Copper Load To The Metro Storm Drain – May 29, 1985

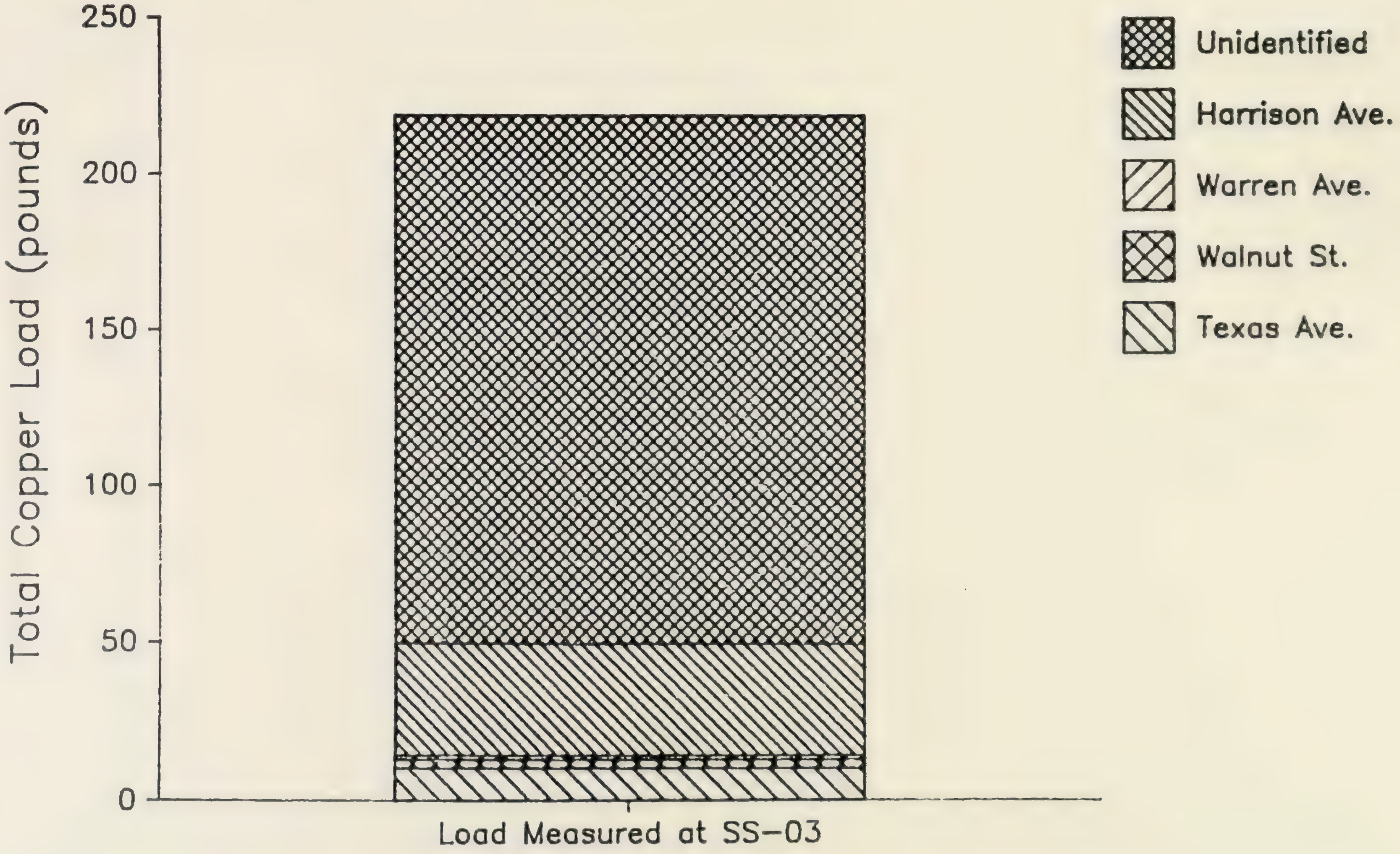


FIGURE 3-21

Total Zinc Load To The Metro Storm Drain - May 29,1985

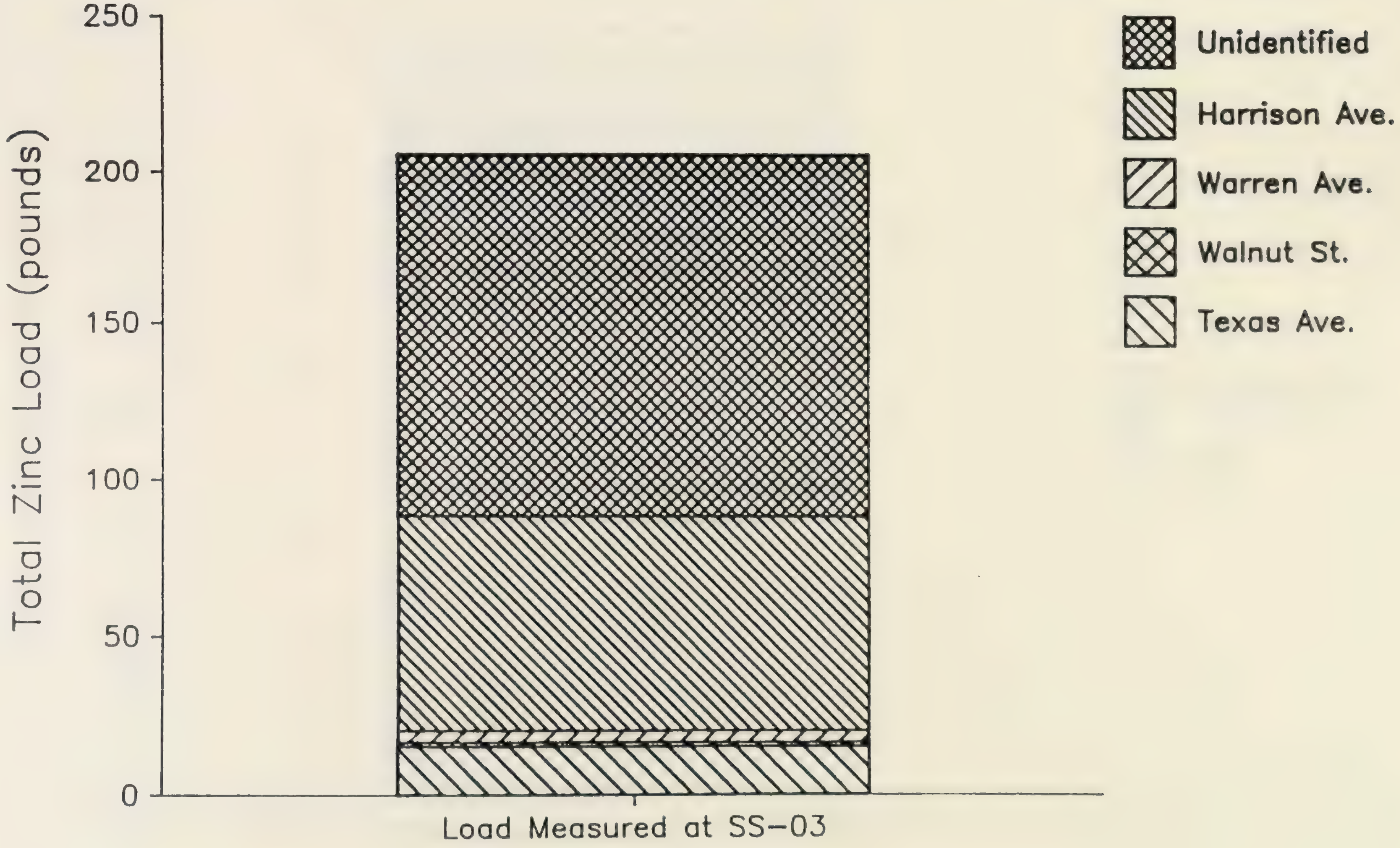


FIGURE 3-22

Total Discharge During Storm Runoff - May 29,1985

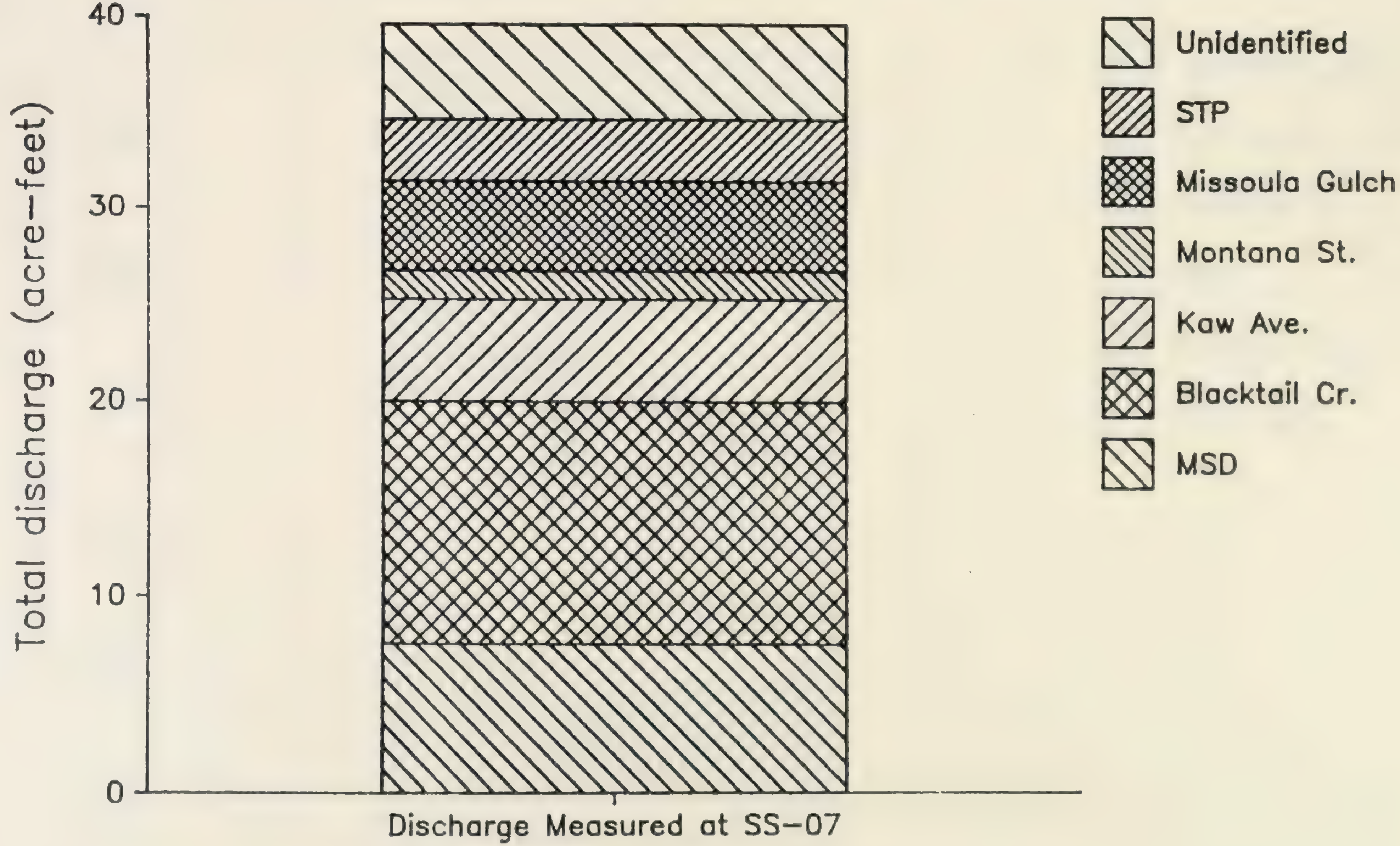


FIGURE 3–23

Major Copper Sources during Storm Runoff – May 29, 1985

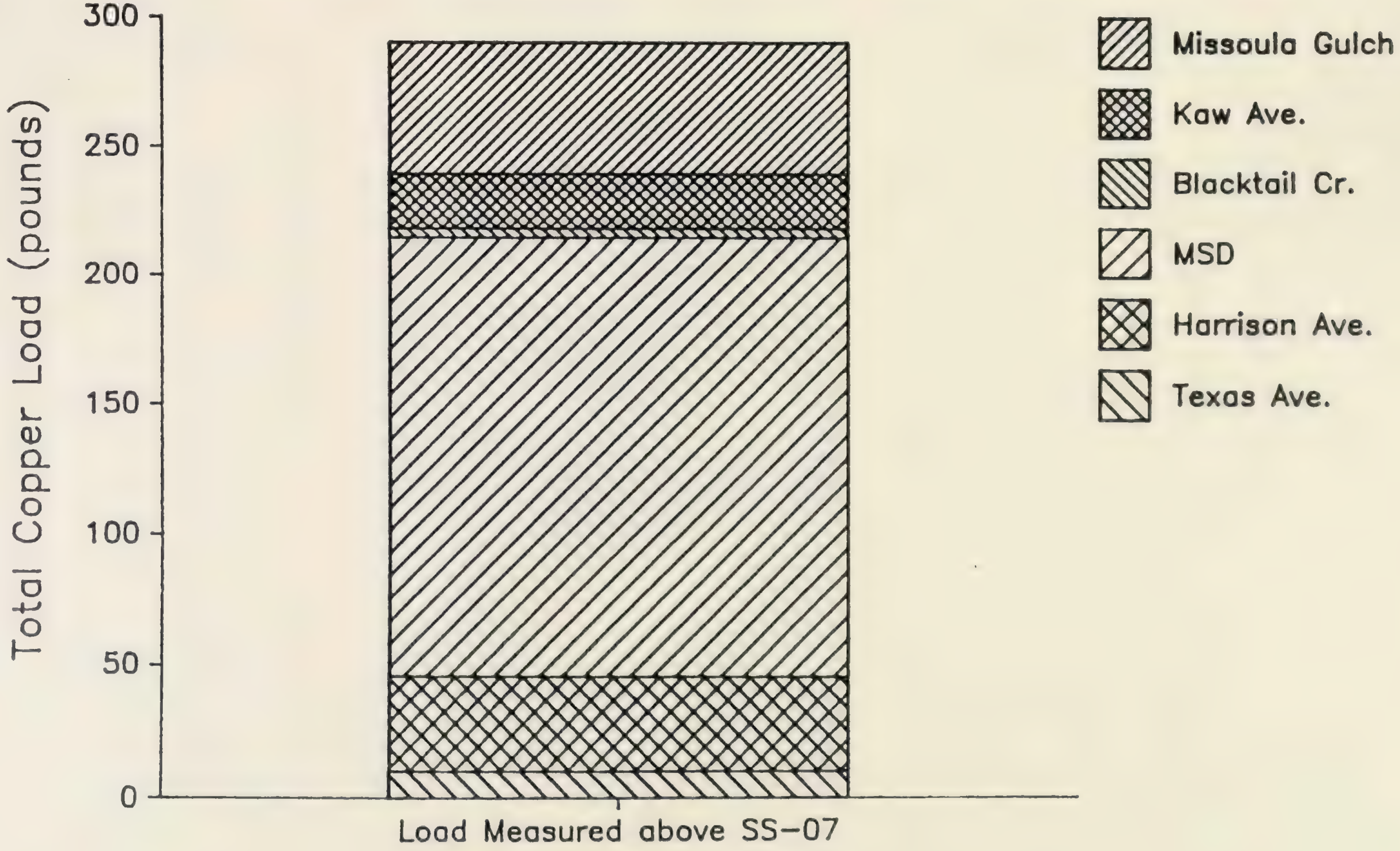
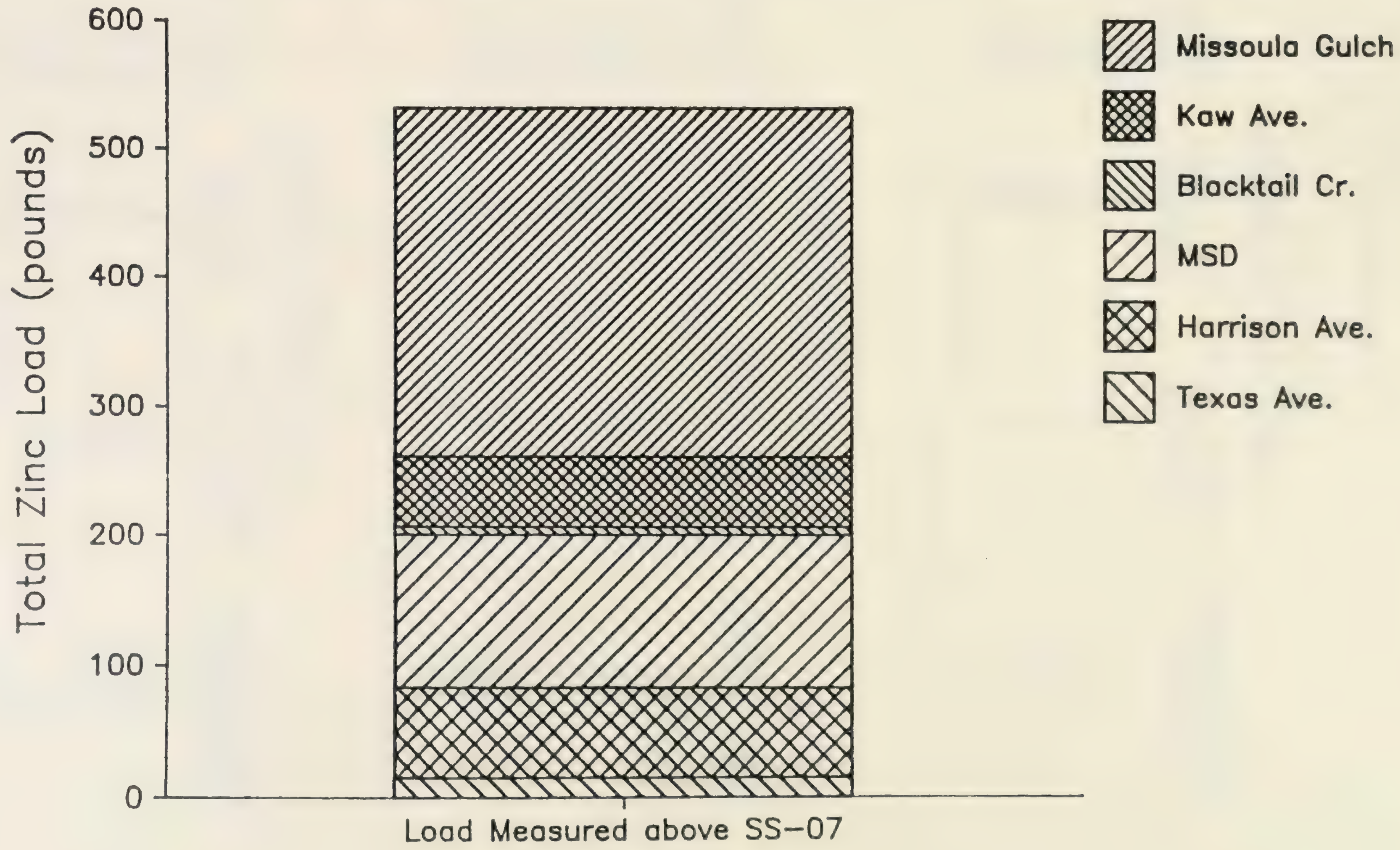


FIGURE 3–24

Major Zinc Sources during Storm Runoff – May 29,1985



ATTACHMENT A-1

COMPOSITE SAMPLE FOR STATION SS-02, TEXAS AVENUE

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	0.70	15	33	23
2	3.00	50	33	98
3	2.00	80	30	60
4	2.00	110	30	60
5	0.90	140	30	27
6	0.70	170	15	11
		Total Discharge =		279
			= 0.38 ac/ft	

COMPOSITE SAMPLE FOR STATION PS-0A, WALNUT STREET

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	3.82	0	10	38
2	7.22	20	23	162
3	11.55	45	48	549
4	13.60	115	50	680
5	9.50	145	28	261
6	7.30	170	30	219
7	5.52	205	33	179
8	4.39	235	15	66
		Total Discharge =		2154
			= 297 ac/ft	

- COMPOSITE SAMPLE FOR STATION PS-01, WARREN AVENUE

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	0.53	0	10	5
2	0.83	20	23	19
3	0.59	45	30	18
4	0.38	80	50	19
5	0.47	145	50	24
6	0.08	180	18	1
		Total Discharge =		86
			= 0.12 ac/ft	

ATTACHMENT A-1 (continued)

COMPOSITE SAMPLE FOR
STATION PS-02, HARRISON AVENUE

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	0.75	0	8	6
2	15.50	15	15	233
3	19.76	30	15	296
4	14.11	45	15	212
5	16.93	60	15	254
6	17.64	75	18	309
7	7.22	95	25	181
8	6.47	125	33	210
9	1.41	160	30	42
10	0.66	185	13	8
		Total Discharge =		1751
			= 2.41 ac/ft	

COMPOSITE SAMPLE FOR
STATION SS-03, METRO STORM DRAIN AT KAW AVENUE

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	1.86	0	17	32
2	37.65	34	33	1224
3	43.60	65	48	2093
4	28.70	130	65	1866
5	9.03	195	33	293
		Total Discharge =		5508
			= 7.59 ac/ft	

COMPOSITE SAMPLE FOR
STATION SS-04, BLACKTAIL CREEK

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	17.10	0	30	513
2	18.20	60	53	956
3	52.80	105	45	2376
4	61.05	150	60	3663
5	39.61	225	38	1485
		Total Discharge =		8993
			= 12.4 ac/ft	

ATTACHMENT A-1 (continued)

COMPOSITE SAMPLE FOR
STATION PS-05, KAW AVENUE STORM DRAIN

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	0.42	8	22	9
2	49.80	35	30	1494
3	27.30	68	48	1297
4	14.70	130	44	639
5	8.40	155	28	231
6	1.88	185	88	165
		Total Discharge =		3835
			= 5.28 ac/ft	

COMPOSITE SAMPLE FOR
STATION PS-04, MISSOULA GULCH

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	0.34	8	19	6
2	38.47	30	30	1154
3	33.78	68	38	1267
4	15.16	105	46	697
5	3.62	160	58	208
6	0.83	220	60	50
7	0.17	280	35	6
		Total Discharge =		3388
			= 4.67 ac/ft	

COMPOSITE SAMPLE FOR
STATION PS-08, STP

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	13.10	0	15	197
2	13.10	30	30	393
3	12.50	60	30	375
4	11.70	90	45	527
5	9.90	150	60	594
6	8.70	210	30	261
		Total Discharge =		2347
			= 3.23 ac/ft	

ATTACHMENT A-1 (continued)

COMPOSITE SAMPLE FOR
STATION SS-07, SBC AT USGS GAGE

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	35.70	0	15	536
2	50.40	30	30	1512
3	124.00	60	30	3720
4	162.00	90	30	4860
5	158.00	120	30	4740
6	137.00	150	45	6165
7	92.00	210	60	5520
8	56.70	270	30	1701
		Total Discharge =		28754
			= 39.6 ac/ft	

COMPOSITE SAMPLE FOR
STATION PS-03, MONTANA STREET

SAMPLE NO.	DISCHARGE (CFS)	SAMPLE TIME (MINUTES)	SAMPLE INTERVAL (MINUTES)	DISCHARGE AMOUNT (CFS-MINUTES)
1	1.62	0	15	24
2	6.79	30	30	204
3	10.20	60	30	306
4	11.40	90	45	513
5	0.25	150	60	15
6	0.03	210	30	1
		Total Discharge =		1063
			= 1.46 ac/ft	

TABLE 3-1
CHEMICAL LOAD VALUES FOR SAMPLES ANALYZED DURING THE MAY 29, 1985 STORM NEAR BUTTE, MONTANA
(LOAD IN POUNDS)

COMPONENT	STATION											
	PS-01	PS-02	PS-03	PS-04	PS-05	PS-08	PS-OA	PS-OA DUPE	SS-02	SS-03	SS-04	SS-07
Metals												
Arsenic, total	0.15	2.25	0.36	6.21	3.23	<0.05	0.38	0.60	0.05	6.80	1.14	16.25
Cadmium, total	0.03	0.45	0.05	1.85	0.36	<0.04	0.06	0.06	0.24	1.83	<0.17	3.34
Copper, total	1.35	35.65	1.69	50.97	21.38	0.25	1.81	3.61	10.34	218.49	3.50	215.21
Copper, dissolved	0.20	10.75	<0.09	2.16	2.28	<0.19	0.65	0.27	11.38	2.14	<0.74	23.57
Lead, total	0.39	9.96	1.93	11.09	6.43	<0.59	1.35	1.49	0.10	30.92	2.62	146.34
Iron, total	11.49	213.62	36.92	503.34	208.09	1.04	38.85	55.78	5.95	944.03	120.48	2119.79
Iron, dissolved	0.01	1.39	0.10	0.71	0.52	0.76	0.36	2.07	0.20	2.35	2.79	6.78
Zinc, total	3.57	68.15	3.08	270.05	54.39	1.02	1.37	3.25	15.45	205.50	6.29	455.16
Zinc, dissolved	1.74	62.38	0.18	20.79	21.67	1.43	0.52	0.32	26.00	27.83	1.68	150.64
Common Ions												
Sulfate	70.48	937.02	83.54	760.72	717.57	368.88	73.35	74.96	694.31	2535.29	975.96	7532.24
Nitrate	1.58	3.67	5.57	22.82	12.06	16.69	8.87	28.21	0.39	17.31	47.12	333.57
Alkalinity, total	20.28	52.42	135.25	431.07	459.24	1053.96	266.00	225.70	6.26	783.26	2052.87	5380.17
Alkalinity, bicarbonate	20.28	52.42	135.25	431.07	459.24	1053.96	266.00	225.70	6.26	783.26	2052.87	5380.17
Alkalinity, carbonate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hardness	80.46	897.71	250.61	887.50	904.14	737.77	314.37	314.37	621.23	2741.41	2624.99	10545.14
TSS	608.26	9435.76	2689.11	33598.30	15499.48	140.53	3409.68	3369.38	283.99	25558.99	3971.14	81778.65

ATTACHMENT A-2

TABLE 3-5
PERCENT DIFFERENCE IN DISSOLVED COPPER LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	**	350	10	-05	36	-11	*	*	57	34		
2	**	147	65	-31	24	06	-28	-08	29	42	*	
3	**	95	94	-40	61	-14	-42	11	-05	69		
4	**	165	212	-52	98	-43	-30	80	-21	09		
5	**	111	88	-35	30	-11	-20	00	27	08		
6	**	-05	64	-41	31	00	-17	-05	11	00	-01	
7	**	38	41	16	-17	-08	05	-01	16	-20	20	-12
8	**	20	38	-22	22	-26	19	10	00	02	04	11
9	**	74	60	-06	62	-30	10	-27	60	-04	69	-49
10	-64	493	95	-20	06	-25	-18	117	-18	03	-58	34
11	**	397	51	10	-02	54	-44	86	05	-34	18	33
12	-65	813	35	-14	26	11	-34	-09	23	-23	-20	86
13	**	1673	51	-30	09	-24	43	00	-34	-02	-27	103
14	**	409	105	-43	23	-13	16	-23	01	16	-15	-02
15	**	498	66	-34	16	-19	-15	18	-04	-10	-04	14
Ave		352	72	-23	28	-10	-11	18	10	6	-1	24

NOTE:
* Questionable Data
** Below method detection limit.

TABLE 3-6

PERCENT DIFFERENCE IN TOTAL COPPER LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	27	282	37	46	32	-05	*	*	73	29		
2	-46	522	61	12	22	35	-38	45	-13	50		
3	-33	263	77	55	46	00	-45	22	-12	-24		
4	-21	246	73	80	00	264	-70	156	-41	-33		
5	-40	409	40	20	65	-03	-25	-06	12	57		
6	03	10	87	04	88	-13	-23	-27	26	52	33	
7	-42	137	41	25	12	13	-26	-08	13	27	01	19
8	-16	126	28	16	24	-10	13	19	23	32	-11	08
9	*	*	101	-06	38	23	-34	-04	30	01	22	-08
10	-32	406	64	07	35	-05	16	11	13	-04	18	-11
11	30	139	64	-02	29	85	-19	31	45	35	-34	-18
12	-33	303	13	71	17	11	-07	-01	07	03	10	00
13	86	616	72	-10	06	45	-17	-02	00	-26	28	44
14	03	227	54	-24	09	-10	28	-26	12	01	-27	-14
15	00	663	74	-41	62	16	-06	05	05	25	03	-34
Ave	-08	311	59	17	32	30	-18	15	13	15	04	-2

NOTE:
* Questionable Data

TABLE 3-7
PERCENT DIFFERENCE IN DISSOLVED ZINC LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	**	71	-24	-69	-05	-05	*	*	33	-05		
2	-39	140	104	08	03	06	-12	-07	21	37		
3	-51	163	110	14	-03	-14	12	06	02	17		
4	-83	406	202	-16	-01	-16	14	17	-10	24		
5	-40	204	102	-15	-10	23	04	-01	16	19		
6	-51	61	132	-21	-10	22	11	00	18	06	-19	
7	-83	142	116	07	-03	-22	48	-06	13	02	00	07
8	-01	72	81	-21	12	-20	25	09	-05	-13	09	37
9	-45	152	118	-08	23	-25	33	-11	15	-27	24	14
10	-51	202	111	-14	-33	31	-02	-04	50	-62	-05	12
11	-27	199	105	-32	-42	158	-18	-27	158	-58	-65	57
12	26	91	31	-19	-02	-01	-20	01	-03	-36	-19	22
13	1435	87	131	-69	-79	07	1057	-39	-62	-62	145	-31
14	-39	311	138	-40	-34	-20	125	-21	-43	-48	-48	22
15	-69	257	125	-23	-51	-64	418	-08	-53	-61	-18	22
Ave	63	171	105	-21	-16	4	121	-6	10	-18	0	18

NOTE:
* Questionable Data
** Below method detection limit.

TABLE 3-8
PERCENT DIFFERENCE IN TOTAL ZINC LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	206	59	-18	-60	05	00	*	*	43	01		
2	-22	114	108	26	02	24	-26	19	01	37		
3	-53	117	105	38	27	00	-25	29	-19	18		
4	-79	305	137	38	03	73	-36	54	-25	-15		
5	-31	164	88	08	16	13	-10	-02	09	32		
6	-52	01	151	-06	43	06	-08	-06	13	28	15	
7	-71	126	60	21	05	04	-06	03	03	28	-01	03
8	07	51	86	00	11	-06	14	19	16	11	00	07
9	-35	98	101	05	39	13	-08	-14	19	-07	43	-15
10	-48	170	109	-09	17	12	22	-03	19	-18	18	-08
11	-30	196	123	-16	30	93	-24	16	59	05	-24	-28
12	-12	52	19	-09	-11	06	122	-50	00	-19	05	00
13	82	122	107	-32	00	42	20	-08	-12	-27	25	23
14	-30	232	161	02	-20	-11	57	-17	-05	-09	-34	-13
15	-63	241	123	-27	05	00	42	01	-17	10	05	-23
Ave	-15	136	97	-1	11	18	10	3	7	5	5	-6

NOTE:
* Questionable Data

TABLE 3-9
PERCENT DIFFERENCE IN DISSOLVED IRON LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	**	-46	00	51	14	-28	*	*	12	15		
2	**	**	12	-15	02	20	-17	06	02	13		
3	**	-73	222	-63	-19	03	-08	16	06	-16		
4	-87	-68	*	*	-20	-44	69	-53	131	-32		
5	**	-57	120	-27	-20	-36	-09	-02	04	06		
6	-51	-23	19	-15	-32	13	-31	-07	100	-40	-03	
7	-50	03	63	25	-11	-20	53	-20	13	-32	38	-18
8	-29	*	*	-10	-71	-03	56	66	-39	-52	40	205
9	24	-44	-33	-66	49	167	52	-22	16	-71	399	60
10	-30	-32	100	-05	-73	81	-47	102	06	17	-63	105
11	-28	-35	86	-14	-36	170	-18	65	05	-62	26	05
12	-28	-51	181	-56	42	26	382	-94	55	-33	-31	89
13	**	-11	31	-02	142	-80	14	151	-14	-71	39	77
14	-50	-23	122	-30	-09	-70	323	-21	-57	13	04	112
Ave	-36	-38	77	-17	-3	14	63	14	17	-25	50	79

NOTE:
* Questionable data
** Below method detection limit.

ATTACHMENT A-1

FIGURE 3-19

Total Discharge Into The Metro Storm Drain – May 29,1985

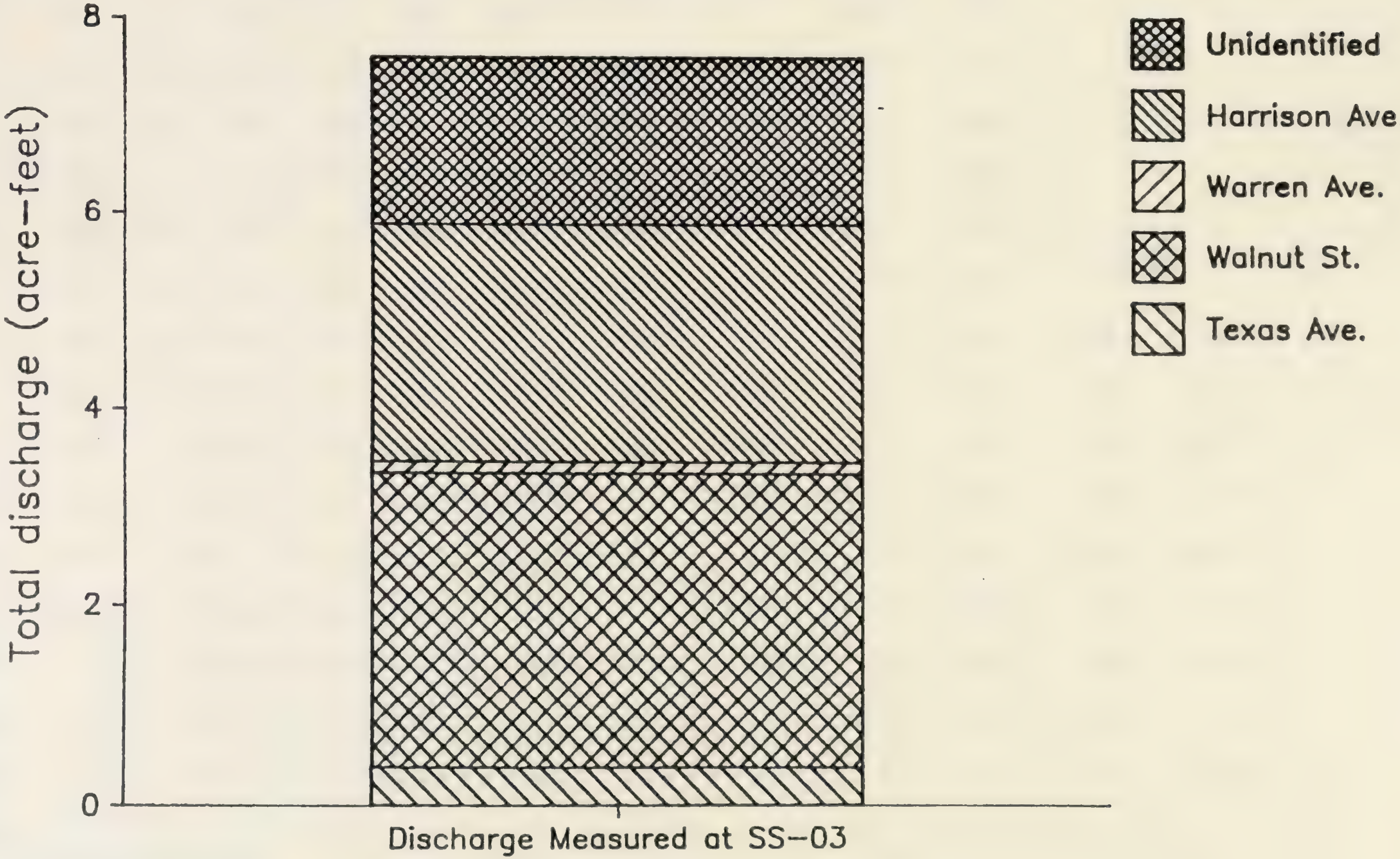


TABLE 3-10
PERCENT DIFFERENCE IN TOTAL IRON LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	39	-21	65	43	25	-02	*	*	88	27		
2	33	25	36	00	33	50	-42	80	-17	22		
3	36	-28	42	84	42	-06	-32	23	-19	-08		
4	-55	17	37	141	-06	399	-75	170	-44	-49		
5	35	-09	-10	80	41	-03	-22	-06	29	55		
6	-01	-65	95	26	154	-29	-20	-02	19	43	86	
7	02	52	-35	48	04	11	-28	18	-11	57	-08	05
8	12	-10	24	58	-08	15	27	03	30	05	-04	05
9	530	12	-22	13	47	25	-11	-09	11	06	50	-10
10	-17	24	20	31	16	-01	10	07	14	20	09	-09
11	-32	56	17	46	36	293	-28	47	27	24	-34	-36
12	-48	-41	-22	119	15	03	73	-47	06	05	11	07
13	11	38	31	20	17	48	-12	04	03	-30	28	189
14	31	41	62	36	-05	04	70	-10	-10	17	-43	09
AVE	41	6	24	53	29	58	-7	21	9	14	10	20

NOTE:
* Questionable Data

TABLE 3-11
PERCENT DIFFERENCE IN SULFATE LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	25	01	06	-19	07	01	*	*	29	31		
2	-04	30	06	16	03	20	-01	21	00	00		
3	-08	38	17	16	07	-01	53	02	06	10		
4	-35	36	08	09	08	-01	42	05	-18	34		
5	-04	25	-03	15	20	21	14	-03	01	-01		
6	-13	00	30	03	11	19	06	11	-01	00	-06	
7	-31	13	27	16	08	03	18	04	06	08	05	19
8	01	25	13	-02	18	01	15	17	01	02	08	34
9	-09	51	-02	30	00	-04	16	12	-09	06	27	19
10	-17	20	12	15	00	-06	24	09	03	-02	34	00
11	10	26	10	04	11	09	17	08	00	07	10	27
12	-01	30	05	-03	15	24	-17	-02	21	-16	11	24
13	33	42	07	-04	12	23	-07	-05	03	00	27	23
14	-5	42	16	-02	00	11	06	03	-02	-07	-38	76
15	-37	65	20	04	05	13	-16	15	-08	05	11	13
Ave	-6	30	11	6	8	9	12	7	2	5	9	26

NOTE:
* Questionable Data

TABLE 3-12
PERCENT DIFFERENCE IN TSS LOADS BETWEEN STATIONS DURING RI

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	-17	3	72	29	104	-50	*	*	279	-11		
2	93	-29	30	55	2	38	-61	6	2	13		
3	102	-14	-29	133	29	-39	-41	94	-47	2		
4	34	-17	64	42	8	158	-48	71	1	-45		
5	-4	2	-76	78	25	13	-81	129	-26	58		
6	10	-76	81	64	-28	73	-36	12	-06	87	70	
7	28	-37	52	-03	18	-14	-47	24	27	-05	90	-11
8	-4	24	28	-32	21	69	25	7	28	-4	23	17
9	-6	70	-18	11	47	-3	-07	13	2	19	6	-4
10	-5	19	11	6	51	-44	22	5	16	-46	124	20
11	-5	07	-6	4	65	199	5	-2	13	10	-07	18
12	-17	62	-1	-3	5	71	-47	-32	54	11	23	-08
13	1	-3	25	3	8	60	-21	-13	66	5	-16	5
14	172	-44	-63	52	55	63	-65	103	52	34	-14	10
Ave	27	-02	12	31	29	42	-31	32	33	9	33	6

NOTE:
* Questionable Data

TABLE 3-29
PERCENT DIFFERENCE IN RI DISCHARGE BETWEEN STATIONS

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	19	-12	00	07	14	-11	*	*	12	15		
2	00	11	00	-05	02	20	-17**	06	02	13		
3	10	02	08	00	07	03	-08**	-01	06	02		
4	-13	19	02	09	00	-02	12**	06	-12	-07		
5	06	02	04	07	-01	07	-09**	00	04	06		
6	06	-09	15	-05	05	07	-08**	-05	03	06	-03	
7	-06	00	10	02	07	-05	26	-05	00	04	10	06
8	-01	10	04	-08	11	-03	10	10	-04	06	04	11
9	-04	36	-10	03	06	-03	01	07	-03	01	13	09
10	-02	09	-01	-02	09	03	01	05	06	-07	12	10
11	03	07	-06	04	05	-04	02	01	03	00	03	11
12	-08	08	03	-03	-03	17	04	01	07	06	01	26
13	00	21	00	-14	08	07	13	01	00	-02	08	23
14	-06	12	3	2	-07	2	06	02	1	-01	-24	24
15	-10	28	13	-10	-3	2	06	11	-1	7	-6	22
Ave	0	10	3	-1	4	3	8	3	2	3	2	15

NOTE:
* Questionable Data
** Flows measured on different days.

TABLE 3-30
PERCENT DIFFERENCE IN RI LEAD LOADS BETWEEN STATIONS

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	21	-62	121	398	-24	17	*	*	3160	31		
2	-6	11	0	423	-72	12	-32	70	-36	13		
3	33	-34	83	126	42	-36	-16	18	6	-31		
4	-21	52	32	40	23	593	-71	136	-46	-72		
5	-13	42	-35	135	14	-1	-34	30	12	114		
6	-39	-96	39	1065	229	-90	75	1	1	10224	-98	
7	928	-84	-27	40	16	3	-36	-50	0	444	-32	38
8	26	-42	-12	131	-1	14	392	-81	17	1390	-93	-72
9	40	167	-63	106	66	55	-5	0	-3	-10	35	46
10	-5	-27	365	-86	389	408	53	595	-83	40	-11	38
11	-74	130	18143	-99	-26	2532	-77	-20	22	52	31	-14
12	35	8	-12	210	-24	96	2	-54	71	30	-39	108
13	-6	128	-20	-21	42	7	-17	29	15	-7	4	100
14	-55	-1	5	38	-51	72	99	-44	-70	318	-77	18
Ave	62	14	1330	179	44	263	26	48	219	895	-23	33

NOTE:
* Questionable Data

TABLE 3-31
PERCENT DIFFERENCE IN RI ARSENIC LOADS BETWEEN STATIONS

Reach of Silver Bow Creek (SS Numbers)

Run #	3-5	5-6	6-7	7-8	8-9	9-10	10-11	11-13	13-14	14-16	16-17	17-19
1	11	22	62	34	-17	22	*	*	20	62		
2	-3	11	1	15	16	-1	-21	28	-3	46		
3	6	-11	36	30	40	-29	0	-3	1	31		
4	-38	45	29	46	21	193	-35	96	-39	-1		
5	17	51	23	50	17	7	-4	10	-09	44		
6	129	-15	84	25	66	7	-58	59	-33	96	39	
7	-13	32	-53	90	-26	18	2	-7	0	19	80	-44
8	-41	114	71	5	39	11	-5	24	19	21	11	0
9	240	-2	50	-18	69	38	-6	-25	4	8	37	41
10	-4	25	31	42	9	1	36	12	15	1	42	42
11	3	73	-43	143	18	115	7	8	3	-40	-43	345
12	20	16	12	119	-32	90	56	-50	-35	-14	81	236
13	11	65	-82	634	-1	-86	-12	1	-15	455	-79	23
14	-71	605	68	-86	487	45	26	-17	9	119	-56	45
Ave	19	74	21	81	50	31	-1	10	-4	60	12	86

NOTE:
* Questionable Data

ATTACHMENT A-3

FIGURE 3-6

RI COPPER LOADS IN AREA I JULY 22 1985

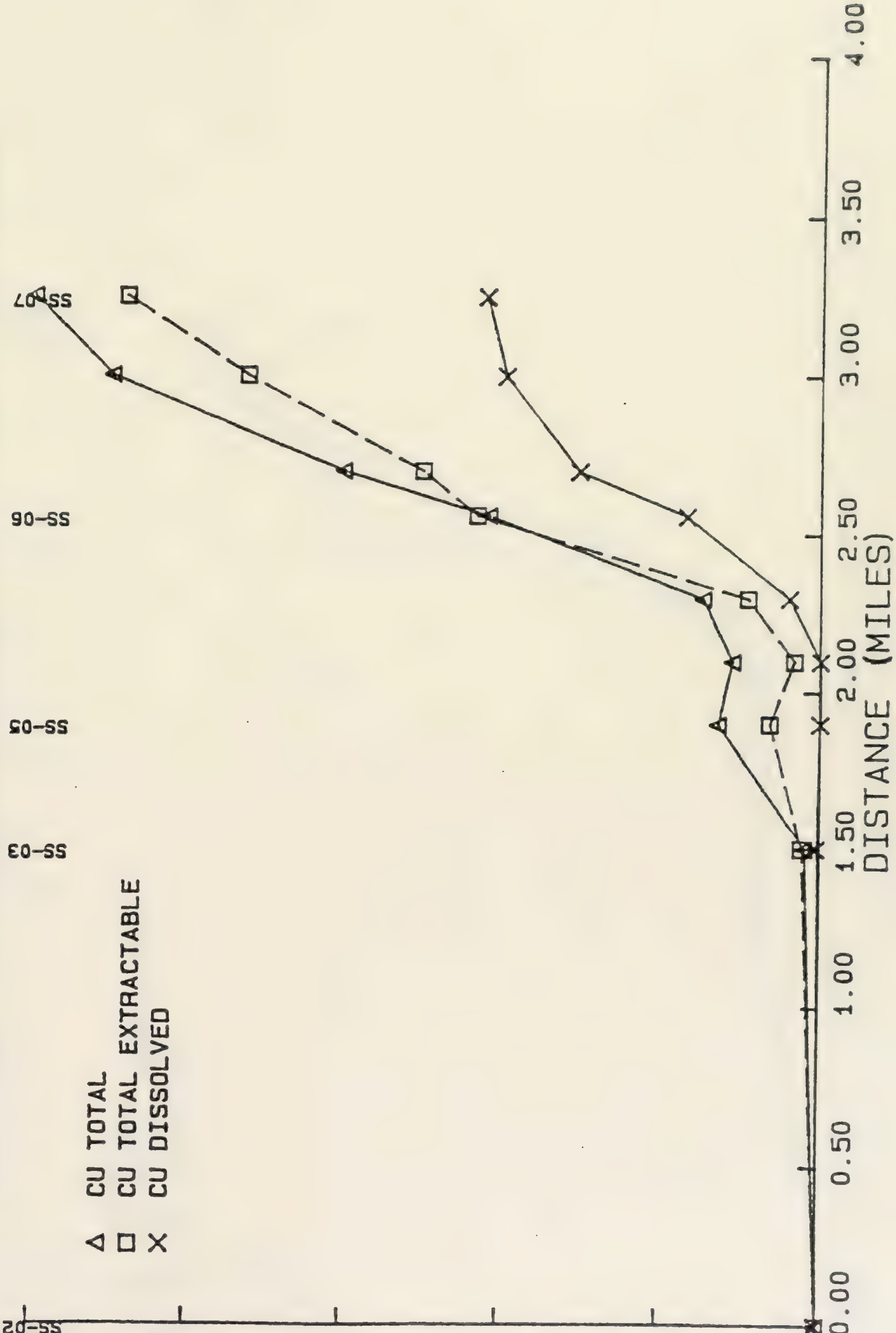
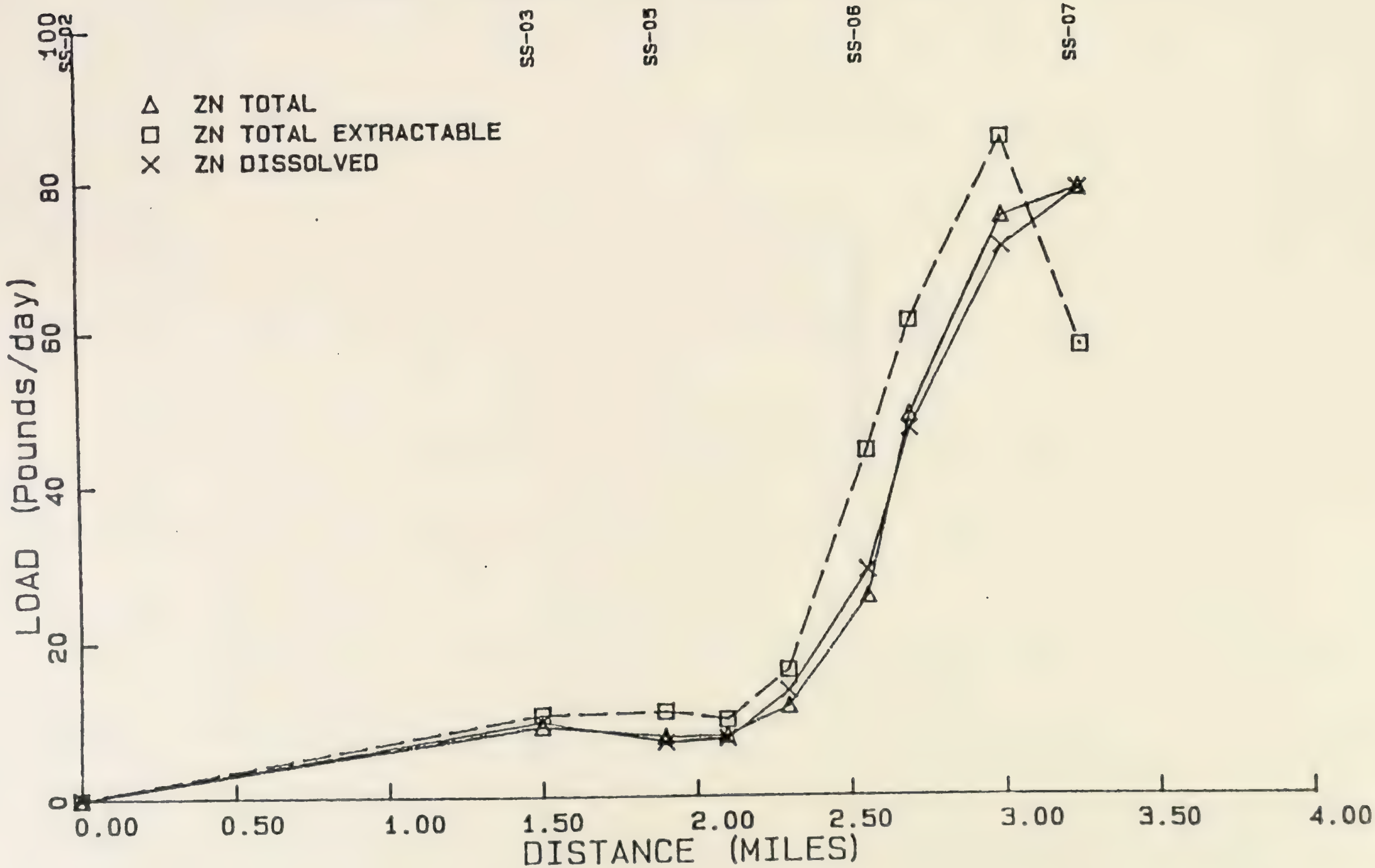


FIGURE 3-7

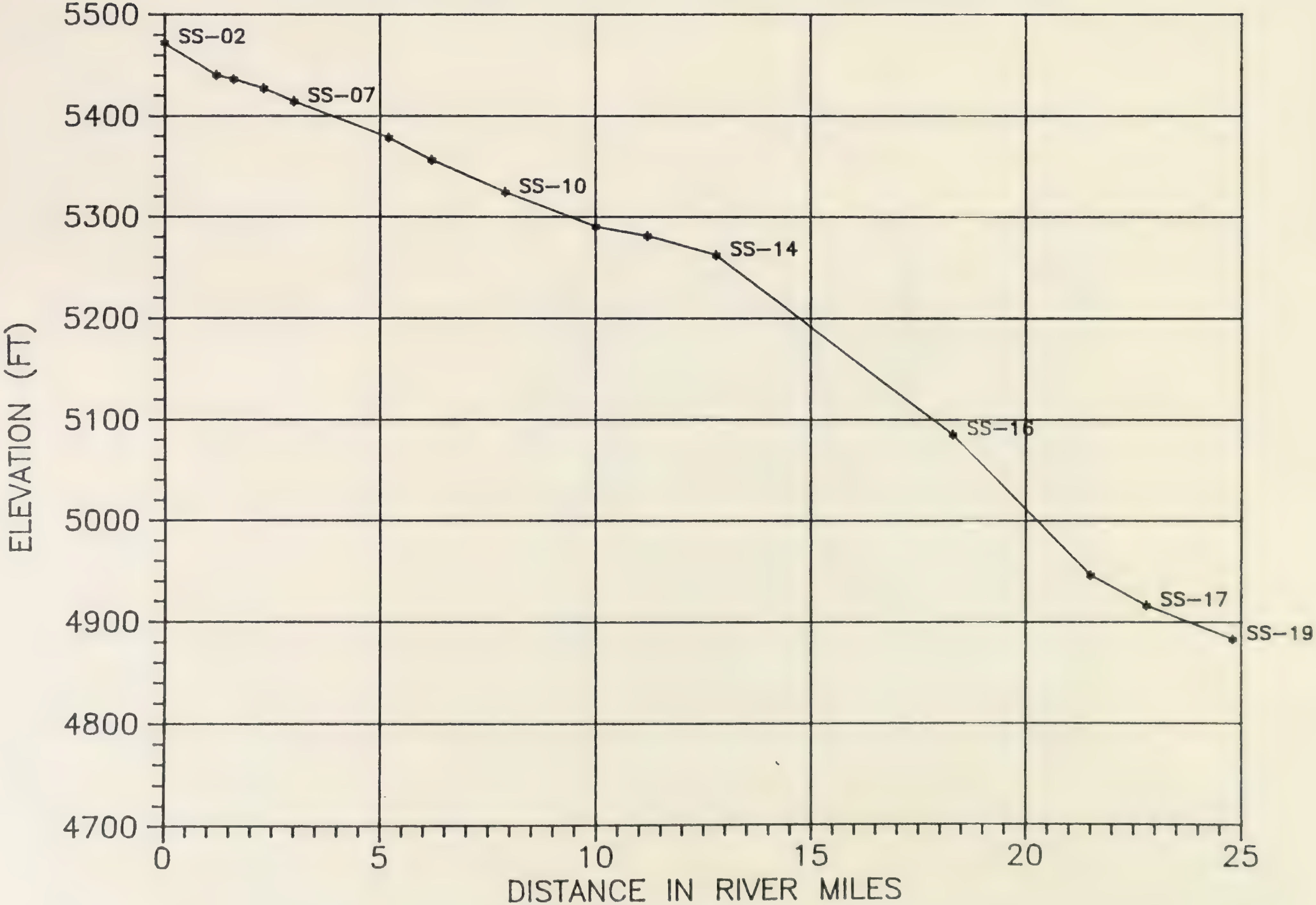
RI ZINC LOADS IN AREA I JULY 22 1985



ATTACHMENT A-4

SBC GRADIENT PROFILE

SILVER BOW CREEK STREAM GRADIENT PROFILE
FROM BUTTE TO WARM SPRINGS PONDS



ATTACHMENT A-5

FIGURE 4—1

MAJOR COPPER SOURCES FOR SILVER BOW CREEK

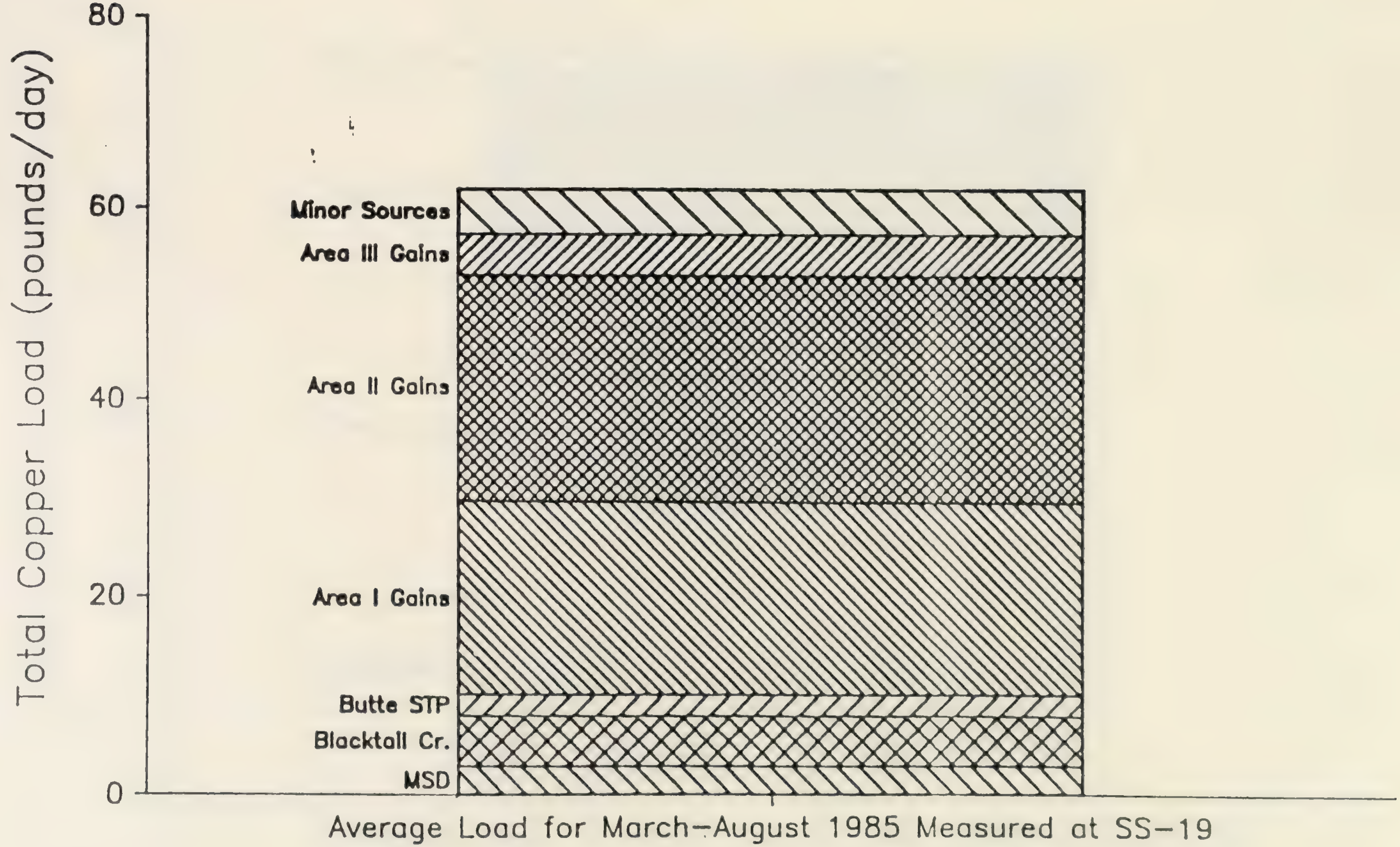


FIGURE 4-2

MAJOR ZINC SOURCES FOR SILVER BOW CREEK

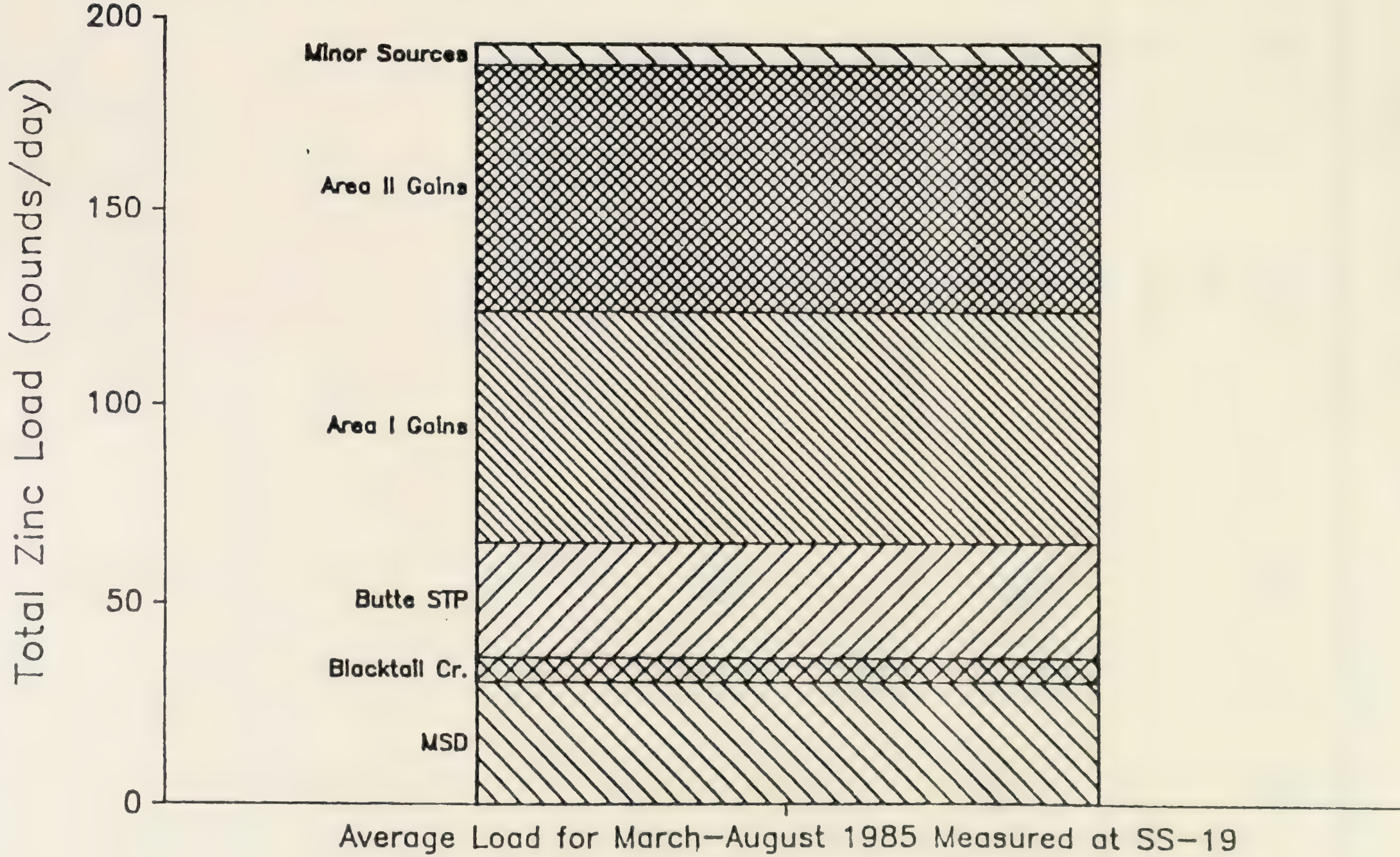


TABLE 3-18
AREA I PRIMARY DRINKING WATER WATER EXCEEDANCES
DURING RI STUDY

(concentrations are in mg/L)

Run#	Date	Parameter	SS-02	SS-03	SS-05	SS-07	PS-04	PS-08	Standard
1	12/03/84	Cd		0.036			.014	.01	.01
		Pb		.15			.075		.05
2	12/26/84	Cd		.117					
3	06/28/85	Cd		.019					
5	02/25/85	Cd		.613					
6	03/11/85	Cd					.016		
		Pb					.650		
		As					.053		.05
7	03/25/85	Cd	.079	.059					
		Pb			.088		.124		
8	04/08/85	Pb					.444		
9	04/22/85	Cd		.040					
10	05/06/85	Cd		.021					
		Pb					.094		
11	05/20/85	Cd		.013					
		Pb				.244			
12	06/05/85	Cd		.070					
13	06/17/85	Cd		.658					
14	07/22/85	Cd		.012					

TABLE 3-32

AREA II PRIMARY DRINKING WATER STANDARDS EXCEEDANCES DURING RI

Run #	Date	Parameter	SS-08	SS-09	SS-10	SS-11	SS-12	SS-13	SS-14	Standard
1	12/04/84	Pb							.111	.05
2	12/26/84	Pb	.055							
3	01/29/85	Cd						.016		.01
4	02/11/85	Pb			.071					
6	03/11/85	Pb		.05						
8	04/09/85	Pb				.067	.38			
9	04/23/85	Pb					.05			
10	05/07/85	Pb						.062		
12	06/03/85	Pb			.05					
	06/04/85	As				.06				
14	07/23/85	Pb					.079			
		As					.058			
		Cd					.135			

NOTE:

All units are mg/L

GROUNDWATER AND TAILINGS INVESTIGATION
(APPENDIX B, PARTS 1-3)

OVERVIEW

An investigation was conducted by MultiTech (1987a) to evaluate the extent and severity of contamination in groundwater that discharges to Silver Bow Creek, to evaluate the significance of tailing deposits as contaminant sources, and to develop other information useful in evaluating remedial alternatives for this CERCLA site.

The results of the Groundwater and Tailings Investigation conducted for the State of Montana by MultiTech establish that elevated concentrations of trace metals and chemical constituents exist in the alluvial aquifer underlying the Metro Storm Drain in Butte and Silver Bow Creek. The significance of these elevated concentrations ranges from slight degradation of the groundwater quality to exceedance of primary drinking water standards. The draft RI report also presents results of investigations of several possible sources of this contamination, all of which are related to mining or milling. In performing these investigations, MultiTech conducted a data collection program consisting of groundwater level measurements, groundwater quality monitoring, and field tests. These data were intended to provide a partial basis for the design of remedial measures for aquifer restoration.

GENERAL COMMENTS

First Paragraph Comment

Analysis of data provided in the Groundwater and Tailings Investigation Report is extremely limited. Several data gaps and unsubstantiated conclusions exist in sections involving hydrology. Methods chosen to analyze aquifer test data may not have been appropriate for the boundary conditions that exist within the groundwater flow system. Boundary conditions (e.g. recharge areas, discharge areas, leakage) need to be

interpreted in the report based upon field observations and geohydrologic analysis. Some of the field procedures, especially those pertaining to monitoring well installation, may have invalidated water level measurements and the results of the water quality analysis from the monitoring wells. The estimation of contaminant loadings to Silver Bow Creek from groundwater would be more appropriate if it had been based upon geohydrologic data rather than inferred from surface water quality data. Finally, remedial alternatives should be discussed in the report to determine whether the data provided in the report are adequate.

Response: It is recognized that data gaps do exist following completion of the Phase I Remedial Investigation at the Silver Bow Creek CERCLA site. Because the site includes approximately 50 river miles and includes a study area in excess of 100 square miles, it was not anticipated that all data necessary to complete a feasibility study at the site would be collected during this effort. Rather, the objective of the study (MultiTech, 1984, p. 1-2) was to collect requisite data to assess the extent and severity of contamination in the Silver Bow Creek-Upper Clark Fork River system. The RI report produced serves to summarize this assessment and focus subsequent studies in areas of greatest concern. It was not intended nor was it presented that this data collection effort would provide all necessary data to definitively describe specific contaminant sources and mechanisms of contaminant movement.

Monitoring wells used for pumping and recovery tests were not specifically designed as production wells; the primary purpose of the wells was to provide access to the groundwater system for sample collection and water level measurement. Aquifer tests performed at selected monitoring wells were completed to gain a general understanding of basic hydraulic characteristics such that relative comparisons between regions within the study area could be made. Aquifer test data presented in the report were analyzed by a variety of methods appropriate to the types of groundwater systems

encountered and as limited by the array of observation wells available at any given site. The method chosen to present the data was used for simplicity sake; the collected data are certainly amenable to interpretation using other methods. Analyses completed using the various analytical and type-curve methods resulted in similar results for the various wells tested. Hence, an exhaustive discussion regarding aquifer performance, given the limitations of the data and observation well arrays, was not considered appropriate in this report.

Monitoring well installation techniques utilized during the Phase I RI were in accordance with those presented in the project work plan (MultiTech, 1984a) and represented the standard of practice as of that date. Continued refinement in monitoring well construction technology has resulted in possibly more advanced installation designs to minimize cross contamination in a properly constructed monitoring well. It is unlikely that groundwater data collected during the Phase I RI are invalid because of construction designs used. However, in certain circumstances, it may be appropriate to construct and sample a limited number of monitoring wells adjacent to selected Phase I wells in accordance with today's standards such that analyses of the data can be refined. AMC certainly may, under State order and appropriate supervision, pay for and install confirmatory wells.

Direct calculations of groundwater contaminant loadings to Silver Bow Creek were attempted but not presented owing to data gaps which rendered presentation of such analyses unsuitable. Foremost of these data gaps was the lack of hydraulic characterization of the shallow groundwater system in the Metro Storm Drain-Upper Silver Bow Creek area. Because low and base flow conditions were prominent during the time period when the Phase I RI was conducted, the situation afforded an excellent opportunity to characterize groundwater input based upon an analysis of surface water data. This type of analysis is not considered less appropriate than direct hydrogeologic analysis. In some cases, the accuracy realized from such an indirect approach is

greater than utilizing the assumptions inherent in many types of groundwater analyses.

Potential remedial alternatives for the study area, from which the Phase I RI field investigations evolved, are presented in "Silver Bow Creek Preliminary Technology Review" (MultiTech, 1984b).

Second, Third, and Fourth Paragraph Comments:

Aquifer Test Analysis

The Cooper-Jacob semi-log method, used to analyze aquifer test data is applicable to artesian aquifers. However, the alluvial aquifer underlying Silver Bow Creek is probably under water table or semi-confined conditions because (according to MultiTech (1987a)) the deposits are unconsolidated valley fill consisting of sand and gravel, and specific sequences of strata within the unconsolidated material do not appear to be laterally continuous or directly correlated. The presence of positive boundaries as represented by a reduction in the rate of drawdown (i.e., slope of data plot) on some of the plots of aquifer test data indicates that a source of additional water has been intercepted by the cone of depression. The source of additional water can be attributed to delayed drainage or vertical leakage that occurs in water table aquifers and leaky aquifers, respectively.

A more suitable method of analysis would be the Walton leaky aquifer method or Boulton water table aquifer method. In cases where the data do not indicate discernible positive boundaries resulting from delayed drainage or leakage, the Cooper-Jacob method or Theis nonequilibrium method may be appropriate (i.e., if the conditions attached to the use of each method are met and the well was pumped for a time period sufficient to negate the effects of any delayed drainage or leakage). Examples of analyses using test data from the report and the leaky artesian method (Walton), water table aquifer method (Boulton), and artesian aquifer method (Theis) are illustrated in Figures 2 and 3. The new calculations

indicate that the hydraulic conductivity at Well GS-08 is less than that provided in MultiTech (1987a) (2.3 gal/day/ft^2 vs. 17 gal/day/ft^2). At Well GS-07, where positive boundary effects were negligible, the newly calculated value is similar to the value in the report but slightly lower (6 gal/day/ft^2 vs. 10 gal/day/ft^2).

Accurate estimates of aquifer parameters are necessary for the design of remedial measures, especially those that involve the pumping or injection of groundwater. Inaccurate values may result in improper design of remedial systems. An understanding of groundwater flow system boundary conditions is also needed to assure proper design.

> Response: Please refer to responses to comments contained in the Opening Paragraph and responses to Specific Comments contained herein. AMC's calculations of hydraulic conductivity for monitoring wells GS-07 and GS-08 are similar to those completed using a similar analytical technique. As well, the resultant hydraulic conductivities are similar to those generated using the Cooper-Jacob semi-log method. The differences in hydraulic conductivity AMC presents for wells GS-07 and GS-08 (2.3 and 17 gpd/ft^2 and 6 and 10 gpd/ft^2, respectively) are insignificant. The result is that the measured hydraulic conductivity in the two wells is very low. "Accurate estimates of aquifer parameters" may be necessary in some cases, and will be evaluated through a more sophisticated aquifer testing program, if necessary, to evaluate the range of remedial alternatives for the various operable units in the study area.

Fifth Through Eighth Paragraph Comments:

Well Completion Practices

According to well completion logs for several monitoring wells installed along the Metro Storm Drain and Silver Bow Creek, two practices were used that could result in inaccurate water quality data or water level measurements from those wells:

- Use of drilling cuttings as backfill for the annulus

- Use of pea gravel as backfill for the annulus.

The standard practice at hazardous waste sites is to backfill the annulus with a cement grout or a cement/bentonite grout (Driscoll 1986; U.S. EPA 1985a). This practice was not followed at any of the wells installed during the RI. The logs of Wells GS-01, GS-03, and GS-15A indicate that drilling cuttings were used to seal the bottom of the hole or to backfill the annulus. The logs of Wells GS-01 and GS-05 indicate that the annulus was backfilled with an unspecified material (assumed to be cuttings). A 3-in layer of bentonite pellets generally was placed between the backfill and the sand pack (monitored zone).

These well completion practices do not ensure isolation of the monitored zone from contamination through the annulus. Because drilling cuttings may contain contaminants, the use of cuttings as fill can bring contaminants in closer association with the monitored zone. Driscoll (1986, p. 724) specifically advises against placing cuttings in any open borehole annulus of a monitoring well.

Well logs for Wells GS-07, GS-08, GS-09, GS-11, GS-12, GS-13A, and GS-14 indicate that pea gravel was used as backfill above the bentonite seal to within a few feet of the ground surface. Use of pea gravel as backfill can cause different problems than does the use of cuttings. Gravel is a geologic material that exhibits hydraulic conductivities 5-6 orders of magnitude greater than the native material in the Metro Storm Drain and Silver Bow Creek area. Groundwater velocity is directly proportional to hydraulic conductivity. Thus, all other variables being constant, groundwater flow velocities would be 5-6 orders of magnitude greater in the pea gravel than in the native material. The result is that contaminants entering the annulus from higher zones would be moved very quickly downward to the bentonite seal if a negative vertical hydraulic gradient existed. A negative gradient does exist during a pump test and at other times (see Groundwater and Tailings Investigation, p. 3-23). Well logs do not indicate that any of the bentonite seals were located

opposite a known aquiclude, which would prevent contaminants from moving laterally from the annulus. In fact, the logs indicate that the seals of many wells (e.g., Wells GS-07, GS-13A, and GS-14) are opposite units that either produce significant water or are lithologically a potential producer, indicating significant hydraulic conductivity. The resulting contaminant pathway would be from the shallow zone of contamination, down the annulus, around the bentonite seal through the native material, and then into the monitored zone. Introduction of contaminants via this pathway could result in groundwater samples with artificially high concentrations of contaminants.

Analysis of aquifer test data from Well GS-08 indicates the presence of a recharge (positive) boundary. This boundary is indicated by a flattening of the drawdown curve on the data plot contained in Figure 2. A recharge boundary indicates that a source of additional water has been intercepted by the cone of depression. Such a boundary might be caused by interception of a surface stream by the cone of depression, delayed drainage from the aquifer, or leakage from an overlying source. The plot was compared with a series of type curves for transient flow in a leaky aquifer and for a water table aquifer with delayed drainage. Interception of a surface stream was eliminated because the drawdown continued to decline. As illustrated in Figure 2, good agreement between the data plot and the type curve for a leaky aquifer was obtained. A similar response would be produced by delayed drainage, but Well GS-08 was not pumped for a sufficient period of time to determine whether delayed drainage was occurring. The consequences of such a condition (leakage) are significant and would impact data interpretation and design of remedial alternatives. If the aquifer were actually leaky and this information was not known, data interpretation could be flawed for the following reasons:

- Composite water level measurements might distort readings from other measuring points

- Inaccurate measurement of water quality within the monitored zone

- o Introduction of contamination into uncontaminated parts of the alluvial aquifer.

Distortion of water levels could result in incorrect interpretation of flow paths and flow velocities and in the incorrect design of remedial alternatives. Inaccurate water quality measurements could result in misinterpretation of the geographical extent of contamination and in the incorrect design of remedial alternatives. Introduction of contamination into uncontaminated parts of the aquifer could result in incorrect assessment of the degree of contamination, erroneous times required for cleanup of the aquifer, and movement of contaminants through flow pathways not controlled by the remedial alternatives.

Response: Please refer to responses to comments in the Opening Paragraph and to Specific Comments contained later in this document which address AMC's comments on monitoring well completion practices in accordance with today's guidance.

Drill cuttings were utilized during construction of several of the monitoring wells installed during the Phase I RI because this was the standard practice at that time. Zones within the borehole annulus where drill cuttings were used for backfill were always sealed with a 1.5 to 3 foot sequence of bentonite pellets. The drilling method involved the use of temporary steel casing and allowed direct backfilling of the annular space between the monitoring well casing and the borehole, which minimized direct contamination of the groundwater system by backfilled drill cuttings. Because zones within the well annulus in which drill cuttings were installed were sealed from the perforated interval with relatively thick sequences of bentonite, (2-3 feet) it is unlikely groundwater monitored in the wells is impacted by the presence of the backfilled drill cuttings. If AMC feels that confirmation of well integrity is necessary, AMC may pay for such confirmatory wells under State order and appropriate state supervision.

Evaluation of well logs for monitoring wells GS-07 and GS-13A indicate bentonite seals were installed at intervals which were considered by the field hydrogeologist as aquitards. The bentonite seal in GS-07 was installed in a silty, clayey sand; measured yield in the unit was approximately 5 gpm. Yields in sand units located above and below the aquitard were 15 and 30 gpm, respectively. The well log for well GS-13A indicates the bentonite plug was placed adjacent to a silty sand with no reported yield. Below this unit was a medium to coarse sand unit which yielded approximately 5 gpm. The well log for well GS-14 indicates the bentonite plug was placed at a depth of 44 to 46 feet below ground surface. This depth coincides with the presence of heaving sands for which an appraisal of lithologic variability was difficult to obtain. The placement of the bentonite plug at this location was based upon the variability of measured groundwater quality field parameters during drilling activities.

Introduction of contaminants into the perforated intervals via the pathway described is possible, although unlikely, given the location of the bentonite plugs with respect to lower permeability zones and the low vertical permeabilities associated with the area's lithologies. It is the State's contention that samples collected from these wells are representative of the groundwater quality of the adjacent groundwater system, especially in view of project objectives to measure the vertical variability in groundwater chemistry in the area and in consideration of the lack of true aquicludes in the site's hydrogeologic environment.

Aquifer tests completed on monitoring well GS-08 were not performed to determine the leakage characteristics of the area's groundwater system. The comments regarding the possibility that interpretations concerning water levels and water quality presented in the Phase I RI were flawed because of the possibility these interpretations may represent a leaky aquifer are applicable only for analyses completed for deeper water bearing zones in the upper Metro Storm Drain area.

Metals contaminant isopleth maps of the shallow groundwater system are unaffected by mechanisms you describe as influencing interpretation of collected data. If deeper groundwater zones in the upper Metro Storm Drain area are leaky, the likelihood that composite water level measurements would distort water level readings from other measuring points and that inaccurate water quality data were obtained from the monitored zone is remote for the following reasons:

- The low permeability environment present in the upper Metro Storm Drain area would serve to minimize the radial and vertical impacts of a monitoring well constructed through a leaky groundwater system. For this reason, it is believed that the impact of constructing monitoring wells in a leaky groundwater system would have no impact on water level elevations in adjacent monitoring wells.

- Introduction of contamination into uncontaminated portions of the alluvial aquifer and subsequent inaccurate measurements of groundwater quality are unlikely because of the previously described low permeability environment present in the area and because the majority of sampled water is derived from areas directly adjacent to the well screen. Horizontal hydraulic conductivities are much greater than vertical hydraulic conductivities in the area's groundwater system and serve to minimize the impacts of a leaky groundwater system on the quality of data generated.

The desirability of assessing the potentially leaky groundwater system in the upper Metro Storm Drain area will be considered prior to completion of a feasibility study of the area. Determinations of the significance of such phenomena will require installation of a much more sophisticated aquifer testing well array and long-duration pumping tests. Such an array would obviate the need for separate confirmatory well construction in the upper Metro Storm Drain area.

Ninth Paragraph Comments

Contaminant Loadings from Groundwater

Contaminant loadings to Silver Bow Creek or the Metro Storm Drain via the groundwater system must be estimated to determine the significance of groundwater as a source of contamination to these drainages. These estimates are a fundamental requirement for design of remedial actions, but these loadings were not estimated directly from geohydrologic data in the Groundwater and Tailings Investigation. Estimates provided in the report were based on a mass balance in which groundwater was assumed to be the source of any unaccounted loadings to the surface water. The report contends that groundwater is a major source of contaminant loading to Silver Bow Creek . Such an assertion must be based upon direct, not inferred, evidence.

Response: Direct calculations of groundwater impacts on the Metro Storm Drain and Silver Bow Creek contaminant loadings were attempted but not presented in the Phase I RI report, primarily because of the lack of adequate hydraulic data to characterize the shallow groundwater system adjacent to the Metro Storm Drain. Direct calculation of groundwater input will require additional hydraulic data to be obtained during additional remedial investigations at the site.

The lack of sufficient hydraulic data notwithstanding, the indirect method of evaluating contaminant loading to receiving surface water systems from groundwater sources is appropriate for the following reasons:

- The Phase I RI was conducted during a drier-than-normal time period, which was conducive to evaluating groundwater inputs to receiving surface water systems that exhibited low and base flows.

- Synoptic flow measurements completed in the area during baseflow conditions determined the contribution of sources other than groundwater. These other inputs were factored out to allow assessment of the magnitude of impacts associated with groundwater input to the surface water systems.

- Back-calculations of groundwater quality necessary to explain the measured contaminant load increases in the various reaches of the surface water system were within the range of measured groundwater quality in areas adjacent to the individual surface water reaches.

Tenth Paragraph Comments:

Remedial Alternatives

One purpose of an RI is to provide data with which to evaluate, select, and design remedial alternatives. The Groundwater and Tailings Investigation report does not provide any discussion of the remedial action alternatives for the Metro Storm Drain and Silver Bow Creek area. Part of the design of a data gathering program is the identification of the end uses (i.e., remedial measures) of the data. It is important that the data provided by the RI are compatible with the needs of remedial measures. Otherwise data gaps will result, and additional data gathering programs may be necessary before design can continue.

Response: Preliminary remedial alternatives for the Silver Bow Creek CERCLA site were identified prior to initiating the Phase I RI. This information is contained in MultiTech (1984b).

SPECIFIC COMMENTS

Specific, page-by-page comments to the groundwater and tailings investigation report are presented below.

1. Page 1-12, Line 9: A figure illustrating the locations of the referenced monitoring wells would be helpful.

   Response: Locations of monitoring wells installed by the Montana Bureau of Mines and Geology (MBMG) are shown on Map 1-2 (Oversize) of the report. Reference to well locations in chapter 1.0 was omitted owing to the authors' desire to introduce the site in general terms. Specific information pertaining to locations of MBMG monitoring wells are included in Section 3.0 (Data Analysis and Interpretation) of the report.

2. Page 1-14, Line 2: The Colorado tailings were excluded from the Groundwater and Tailings Investigation Report because previous studies were deemed adequate. Discussion of the reasoning used to arrive at that conclusion should be provided.

   Response: The Colorado Tailings were excluded from the Silver Bow Creek Phase I RI because correspondence from the Anaconda Minerals Company (AMC) expressed AMC's belief that existing data adequately characterized the problems at the site. As a result of AMC's correspondence, the Montana Department of Health and Environmental Sciences (MDHES) accepted AMC's evaluation of existing data as being sufficient to characterize environmental contamination.

3. Page 2-8, Lines 1 and 4: A reference to where the samples are archived should be provided. The assumption is that water samples collected during this time were used only for a survey of poor quality water to aid in monitoring well design and are not a part of any database for RI use. Such samples are unacceptable for RI use.

Response: Drill cuttings collected and bagged during construction of monitoring wells during the Phase I RI are stored at CHEN-NORTHERN's soils laboratory in Helena.

The intent in collecting water samples during drilling activities associated with monitoring well construction was to gain a qualitative understanding of vertical variations in groundwater chemistry within each borehole. These were used primarily to aide in identifying completion intervals for individual monitoring wells. It was not intended, nor was it presented that these data are of suitable quality to render definitive analyses of site hydrogeologic characteristics.

4. Page 2-9, Line 19: What procedures were followed to ensure that all materials placed in boreholes were free of contamination? For example, was the the silica sand washed with water of suitable quality? If these procedures were used, they should be referenced.

Response: Decontamination procedures utilized during monitoring well construction activities associated with the Silver Bow Creek CERCLA RI are described in the Project Work Plan (MultiTech, 1984). PVC casing and temporary steel casing used to construct monitoring wells were decontaminated by washing with soap and clean water. Other materials placed into the borehole (bentonite pellets, silica frac sand, backfilled pea gravel, and concrete surface seals) were not decontaminated.

Bentonite pellets were not decontaminated because the swelling properties of bentonite would have rendered placement of the pellets at discrete vertical intervals difficult, should the material been decontaminated with liquids.

Silica frac sand used to fill the annular space adjacent to and above the perforated interval in each well was not washed with water prior to insertion into the borehole. Chemical specifications of frac sand used during RI monitoring well construction activities, as provided by the manufacturer, include the following:

Chemical Determination Description	Percent
SiO_2	98.2
Al_2O	0.49
MgO	0.01
CaO	0.02
K_2O	0.21
Na_2O	0.06
Fe_2O_3	0.14
TiO_2	0.02
LOI	0.40
Feldspar	1.80

Based upon the foregoing specifications, it was decided prior to implementing the drilling program for the RI that the sand to be used in completing the monitoring wells was of sufficient quality that washing was unnecessary. Well development combined with well evacuation procedures utilized following well construction were judged adequate to remove any residual inorganic contamination present within the sand pack.

Pea gravel used for backfill in the annular space above the bentonite seal was not washed or decontaminated because of the impracticality in doing so to such large volumes of material and because of the difficulty in decontaminating pea gravel during the time period of well construction (December and January).

5. Page 2-9, Section on Single Wells and Figure 2-1: The well completion description and accompanying figure indicate a potential pathway of contamination to the monitored interval in each well. Contamination could move from the backfill into the water table and then into the monitored interval. The use of cuttings for backfill increases the chances of moving contaminated material from near the land surface to near the monitored interval. Assuming the monitored interval contains water of better quality than that contained in the backfill, contaminants in the backfill would move around the bentonite seal and into the monitored interval, thus giving an inaccurate picture of the water chemistry. A preferred completion technique is to fill the annulus with bentonite, concrete, or a mixture of the two.

Response: The well completion technique described by AMC is preferable to the monitoring well completion designs used during the RI. However, the standard of practice in constructing monitoring wells in December, 1985 (the time period when the RI wells were constructed) was to install monitoring wells as is depicted in Appendix B, Figure 2-1. The well design utilized was in accordance with the project work plan (MultiTech, 1984a).

The pathway of groundwater movement described above suggests that an inaccurate picture of groundwater chemistry is possible; however, it is not probable in the low permeability environment present within the study area. Typical horizontal permeabilities measured in the Butte area were on the order of 10 to 30 gpd/ft^2. Vertical permeabilities associated with sand and gravel aquifers are from 10 to 20 times less than horizontal permeabilities (Walton, 1987). Vertical permeabilities measured near the lower end of the study area during RI activities at the Warm Springs Ponds were from 30 to 40 times less than calculated horizontal permeabilities. Pumping tests completed during the Phase I RI also indicated minimal vertical interconnectedness in the area's groundwater system. Given these

observations, it is reasonable to assume vertical permeabilities at monitoring well locations in the study area are less than one gpd/ft^2.

Standard procedures used during the RI for sampling monitoring wells involved evacuation of three bore volumes of water prior to sample collection. Assuming total evacuation time prior to sampling of one hour, a vertical permeability of one gpd/ft^2, a gradient of one ft/ft, and an area equal to the volume of annular space occupied by pea gravel backfill (6-inch borehole minus 2-inch casing), the total quantity of water following the tortuous path from the saturated pea gravel, around the bentonite seal, and into the well screen is approximately 0.007 gallons.

To resolve the issue of monitoring well completion practices used during the RI, it may be prudent to construct selected verification wells adjacent to those installed during the RI. The verification wells should be constructed to today's standards and sampled in accordance with EPA-approved procedures. Results can then be compared and evaluated further such that a determination of the utility of Phase I RI monitoring wells for providing accurate characterization of groundwater quality can be made. If AMC so desires, it may conduct and pay for, under State order and appropriate State oversight, the installation of verification wells.

6. Page 2-10, Dual Wells: Were any tests performed to check the integrity of the bentonite seal? If not, how was integrity proven? Leakage between monitored zones may result in distorted water quality data and distorted head measurements.

   <u>Response</u>: Field checks of the integrity of the bentonite seals installed in each monitoring well were performed during well development. Compressed air was typically used to develop monitoring wells to remove drilling debris and to insure adequate communication

between the well and the adjacent water-bearing unit. During this process, the annular space between the installed well casing and the borehole was monitored to determine if water was being evacuated through the annular space in addition to the water exiting through the well casing. This phenomenon was not observed during well development of any of the monitoring wells installed during the Phase I RI.

A separate means of evaluating the integrity of the bentonite seal was made by comparing static water elevations in the dual-completion monitoring wells. In all cases where dual completion monitoring wells were installed, groundwater elevations in the two wells completed in the same borehole were measurably different. If the bentonite seal had failed, the measured groundwater elevations would have been similar, as the two separate completions would adjust to a similar equilibrium level.

7. Page 2-20, Line 8: The discussion of frozen wells should reference well numbers.

   Response: Reference to frozen wells is provided in Appendix B, Part 3, Attachments V-A and V-B of the RI report. The well most commonly affected by frozen water was GS-02.

8. Page 2-23, Line 11: What specific protocols were followed to analyze samples for these variables? These protocols should be noted.

   Response: Protocols used in laboratory analysis of groundwater and vadose zone samples are detailed in Appendix F of the Phase I RI report. Protocols used for analysis of field-determined parameters are contained in Appendix B, Part 2, Attachment IV-C of the Phase I RI report.

9. Page 2-26, third paragraph: How was the decision to end aquifer tests reached (i.e., how was it determined that general aquifer hydraulic characteristics were sufficiently identified and quantified)? The decision must consider the type of aquifer tested and the degree of accuracy desired in establishing aquifer properties. An alluvial aquifer such as the one at Silver Bow Creek is a mixture of permeable and less-permeable materials. This variation, along with a perennial surface stream and unconfined conditions, may introduce a variety of boundary conditions into the test data. The experience of Kruseman and DeRidder (1976) indicates that 15-20 hours of pumping are generally needed to reach steady-state flow conditions (a criterion for ending an aquifer test) in a semiconfined aquifer (similar to the Silver Bow Creek aquifer). Examination of aquifer test data indicates that the tests may have been concluded too early to provide full definition of boundary conditions.

<u>Response</u>: The objective of the series of short-term pumping tests was to gain a general spatial understanding of the relative magnitudes of general aquifer parameters within the study area. The single, 24-hour pumping test was designed to address variables such as lithologic variability, the presence of boundaries, etc.

Longer duration aquifer testing combined with a properly designed observation well network is preferable in evaluating a host of aquifer hydraulic parameters. However, such definition was beyond the scope of the Phase I RI, which was conducted to determine general aquifer characteristics. Evaluations to assess the need for sophisticated aquifer testing within the study area will be completed on an operable unit basis in a future RI. The existing data are not invalid for the purpose for which they were obtained. Their use in determining hydraulic parameters beyond the capability of the dataset is not appropriate.

10. Page 2-26, line 20: Transmissivity and hydraulic conductivity are the only aquifer hydraulic characteristics provided in the analysis of test data. Effective porosity, which is required to model contaminant transport, is absent. Storativity, which is required to model transient groundwater flow, is also missing. Transport parameters (e.g., retardation factor, longitudinal dispersion) are also absent. Ideally, hydraulic conductivity should be expressed in terms of vertical and horizontal tensors. These parameters are generally used in remedial design.

<u>Response</u>: Additional hydraulic and transport characteristics of aquifers associated with the Silver Bow Creek groundwater system may be necessary to evaluate various remedial alternatives for the site. However, quantification of parameters you identify was beyond the scope of the Phase I Silver Bow Creek RI. As is stated in the RI Work Plan (MultiTech, 1984a, p. 4-52), a general characterization of hydraulic characteristics was envisioned during this phase of the RI. This included determinations of transmissivity, permeability, and storage coefficients (where possible). The intent in developing the work plan for the RI was to gain a general understanding of aquifer characteristics in support of identifying contaminant source impacts on receiving surface water systems in the study area. Development of a more thorough understanding of hydraulic and transport characteristics within the study area will involve a much more sophisticated array of observation wells, construction of appropriately completed production wells, and possibly laboratory analyses of physical parameters associated with the aquifers present within the study area. The need to collect these types of data will be evaluated for possible inclusion in a future RI.

11. Page 2-30, third paragraph: The choice of the analytical techniques by which to calculate aquifer parameters should be based upon the character of the groundwater flow system. However, no preliminary conceptual model is provided to support this choice. How was the

choice of technique made? The Jacob method used is appropriate for confined, homogeneous, isotropic aquifers. However, the alluvial aquifer in question is unconfined or semiconfined, nonhomogeneous, and possibly anisotropic (based on data from TS-01). There are also limiting rules about use of the Jacob method that may not be satisfied by these tests.

Response: The Cooper-Jacob straight-line method was used to analyze the aquifer test data because the method is graphically the easiest to interpret. Boundary conditions can be easier to recognize using the straight-line technique than they are using a log-log plot type of analysis, required for other methods. In addition, it is generally easier for the reader to visually interpret the line and the accompanying values using this technique, rather than trying to graphically show match-points and calculations using log-log plots.

Theis, Boulton, and Stallman methods were used initially to interpret the data, but these techniques were either in close agreement with the Cooper-Jacob method, or the methods proved inappropriate given the lack of observation wells or the lack of response in observation wells. The aquifer test data have been reanalyzed and are presented when specifically discussed in this document.

12. Page 3-1, Line 2: The reader is left to assume that RI data are emphasized over historic data because of better QA/QC, but this should be stated to avoid misunderstanding. The exclusion of historic data must be justified. These historic data may provide an understanding of past conditions, and if they are of a suitable quality the data should be included in interpretation.

Response: Historic data available for the study area were evaluated and screened in accordance with certain criteria to ascertain the utility of the data in evaluating and quantifying site hydrogeologic conditions. Data which were deemed acceptable were included in the

interpretation of site conditions and temporal trends. General criteria used to screen and evaluate of historic data included the following:

- o Monitoring wells -- Well locations must have been identifiable. Well completion logs or drillers logs must have been obtainable. Well constructor must have been identifiable.

- o Groundwater quality data -- Sampling agency or individual must have been identifiable. Sampling date must have been identifiable. Determination of sampling method and methods of analyses was preferable. Availability of QA/QC records (e.g. chain of custody forms, completion of duplicate or blank analyses) was preferable.

- o Aquifer test data -- Agency or individual responsible for completing test must be identifiable. Dates of aquifer test must be identifiable. Locations and completion information on tested wells must have been identifiable.

13. Page 3-1, second paragraph: What QA/QC procedures were used for water level monitoring? If chemistry QA/QC is provided, so should that for water level monitoring and aquifer test data.

    Response: QA/QC procedures used in obtaining water level measurements under both static conditions and associated with aquifer testing are described in the project work plan (MultiTech, 1984a, Section 4.4.5.4). Electric well probes used during the RI were calibrated to steel tapes on a periodic basis throughout the duration of the investigation. When calibration checks revealed discrepancies of greater than 0.1 feet, appropriate changes to the resulting data base were instituted, and electric well probes were serviced to bring the accuracy of the instrument to within tolerance limits.

Pressure transducers used during aquifer testing were calibrated in accordance with manufacturer recommendations prior to the start of each test. Barometric pressure was monitored throughout the duration of each test such that appropriate adjustments to collected data could be made.

14. Page 3-4, Line 6: No justification is provided for the statement that mountain snowpack is important to the behavior of the Silver Bow Creek groundwater system. While it is most probably true, evidence should be provided in the form of measurements or a conceptual model based upon field data.

    Response: Data were not collected during the RI specifically to characterize the influence of mountain snowpack on the Silver Bow Creek groundwater system. The intent of the referenced paragraphs in the RI document was to quantify climatic conditions in the study area during the time period in which RI data collection occurred. Several studies (e.g. Dunne and Leopold, 1978) have described the importance of mountain snowpack as a recharge source for groundwater both directly and via surface water courses in intermountainous basins in the West. Quantification of the influence of mountain snowpack on the Silver Bow Creek groundwater system will require synchronous data collection of groundwater levels, surface water stage, snowpack accumulation and moisture content, and meteorological information through a reasonable time period. The need to collect these types of data will be evaluated on an operable unit basis during future remedial investigations.

15. Page 3-5, Line 11: The text excludes other potential sources of lasting effects. The data also represent the lasting effects of natural sources and sources other than mining.

    Response: Future remedial investigation to be completed for the various operable units within the study area will address other contaminant sources present, not just those related to historic mining and milling activities.

16. Page 3-10, Line 16: What is the source of data on tailings thicknesses between Montana Street and Rocker?

Response: Tailings thickness along the reach of Silver Bow Creek between Montana Street and Rocker was determined through review of drilling logs provided by the Montana Bureau of Mines and Geology (primarily in the Butte Reduction Works and Colorado Tailings area), by visual inspection along cutbanks of Silver Bow Creek, through analysis of work completed in the area by Hydrometrics (1983), and through drilling activities associated with the RI (drill holes GS-12, GS-13A, and GS-13B).

17. Page 3-18, Line 18: The water level was already declining when discharges from the concentrator ceased. The water level declines began 4 months prior to cessation of those discharges. The sentence should be reworded to read "cessation of discharges from the concentrator in February 1983 occurred during a period of water level decline which began 4 months earlier."

Response: Presented data contain only one data point prior to February, 1983. Hence, to suggest a period of water level decline was occurring for four months prior to termination of discharge from the concentrator based upon one data point is extrapolating the data beyond its limits. Figure 3-3 depicts a decline during this time period because the first data point following February, 1983 corresponds to a lower groundwater elevation. It is entirely possible that the configuration of the plot may have been level until February, 1983 and then would have shown groundwater level declines. The component of the plot with data from monitoring well DW-116 (a well located beyond the influence of the upper Metro Storm Drain area) was intended to illustrate this point.

18. Page 3-23, second paragraph: On page 3-38 there is reference to completion problems at Well GS-10A that precluded the use of water chemistry data from it. What were the problems? They should be

referenced in this paragraph. What are the ramifications of completion problems on water level measurements?

Response: Apparently AMC is referring to monitoring well GS-10B in the comment. Well completion problems associated with monitoring well GS-10B are described on page 3-38. The ramifications of completion problems in well GS-10B on water level measurements are difficult to quantify. However, the water level data collected from monitoring well GS-10B are usable for the following reasons:

- o Depth of completion -- Because the total depth of GS-10B is 29 feet and material encountered in this portion of the borehole consisted of coarse grained fill material overlying tailings, it is assumed the upper aquifer characterized by this well is unconfined. Therefore, the failure of the sand pack during construction of this well would not serve to alter the piezometric head produced by the well.

- o Yield -- Although well GS-10B does not yield significant quantities of water, the well did recover to static conditions following sampling events. This indicates the well is connected to the adjacent groundwater system, and, given the aquifer is likely unconfined, supports the likelihood that measured water levels are representative of the upper portion of the area's groundwater system.

- o Comparison to other wells -- The fact that the water level in GS-10B is consistently and measurably different from that measured in nearby deeper wells GS-10A and GS-07 indicates the well is providing data from a unique zone of the groundwater system. If groundwater levels were similar to that of the deeper completion in well GS-10A, the consequences of the completion problems associated with well GS-10B may be more pronounced.

19. Page 3-23, line 7: The value for the vertical gradient is not justified by data. Information related to the date of water level measurements and their values must be referenced. The stated values are not verifiable. For example:

Well (Depth)	Measuring Elevation (ft)	Depth to Water (ft) 18 Dec 1985	Water Level Elevation (ft)
GS-11 (shallow)	5,457.55	-11.7	5,445.85
GS-09 (intermediate)	5,457.78	-10.5	5,447.28
GS-08 (deep)	5,458.02	-11.5	5,446.52
GS-10B (shallow)	5,477.94	-22.1	5,455.84
GS-10A (intermediate)	5,477.94	-20.3	5,457.64
GS-07 (deep)	5,469.89	-25.1	5,454.79

The readings for both well clusters have the same gradient pattern, which is downward in the shallow part of the aquifer and upward in the deeper part of the aquifer. However, the report indicates a downward gradient for the GS-11 cluster and no vertical gradient for the GS-10B cluster. An understanding of vertical hydraulic gradient is important because they indicate points of recharge to and discharge from the aquifer. The determination of such information is an objective of the RI itself. Conclusions made in the RI concerning aquifer recharge and discharge areas are affected by this information. Water levels should also be measured to 0.01 ft to be consistent with measuring point elevations and USGS standards.

Response: Data presented by AMC for December 18, 1985 were collected approximately two weeks following well construction and prior to development of these wells. Installed monitoring wells may not have attained equilibrium by this date, nor was adequate communication between the wells and the adjacent aquifer realized until well development was finished. A more accurate appraisal of vertical changes in groundwater level data is made by evaluating data collected during January and June, 1986, dates subsequent to well

development and which provide the expected temporal range in groundwater elevations. These data are presented in the following table:

Well (Depth)	Measuring Elevation (ft)	Depth to Water (ft) 15 Jan 1986	Water Level Elevation (ft)
GS-11 (shallow)	5,457.55	-11.1	5,446.45
GS-09 (intermediate)	5,457.78	-10.4	5,447.38
GS-08 (deep)	5,458.02	-11.3	5,446.72
GS-10B (shallow)	5,477.94	-19.9	5,458.04
GS-10A (intermediate)	5,477.94	-21.9	5,456.04
GS-07 (deep)	5,469.89	-25.1	5,444.79

Well (Depth)	Measuring Elevation (ft)	Depth to Water (ft) 13 Jun 1986	Water Level Elevation (ft)
GS-11 (shallow)	5,457.55	-10.5	5,447.05
GS-09 (intermediate)	5,457.78	-10.1	5,447.68
GS-08 (deep)	5,458.02	-11.0	5,447.02
GS-10B (shallow)	5,477.94	-19.6	5,458.34
GS-10A (intermediate)	5,477.94	-21.8	5,456.14
GS-07 (deep)	5,469.89	-25.1	5,444.79

Data presented in the foregoing tables clearly indicate a downward gradient in the vicinity of the GS-07 well cluster, located near the upper end of the Metro Storm Drain. Data from the GS-08 well cluster, located near the middle reaches of the Metro Storm Drain, suggest that a slight upward gradient is present between the shallow and intermediate completions. However, in comparing shallow and deep completion data, little variability in water levels exists.

Static water levels were measured to 0.01 feet in the field and rounded to an accuracy of 0.1 feet on the reporting form, an accuracy which is consistent with the calibration requirements set forth in the project work plan (MultiTech, 1984a, p. 4-57).

20. Page 3-23, third paragraph: A third explanation of the downward gradient observed near the Metro Storm Drain is drainage of the alluvium along the southern wall of the Berkeley Pit.

Response: Drainage of the alluvium along the southern wall of the Berkeley Pit is another plausible explanation of this phenomenon.

21. Page 3-24, line 6: The statement that groundwater level data from nested monitoring wells indicated no measurable variability in hydraulic head with depth is not substantiated with referenced data. See Comment 19. Because the Metro Storm Drain is a perennial stream, there is evidence that it is a gaining stream, which would indicate an upward gradient.

Response: Please refer to the response to Comment 19. There is some suggestion of upward groundwater movement in multi-depth monitoring wells near the mid-reaches of the Metro Storm Drain, and this may also explain the gaining surface water system in the Metro Storm Drain.

Other factors which likely play a more important role in supplying water to the Metro Storm Drain include the relative difference in gradients between the Metro Storm Drain channel and the underlying groundwater gradient, and the likelihood that the shallow groundwater system exhibits higher permeabilities than underlying material. Higher permeabilities in the shallow groundwater system, although not quantified during the RI, are likely given the history of the area indicating the Silver Bow Creek channel was placer mined in this reach of the stream.

Placering activities typically result in better-sorted, less-layered stratigraphies, with resulting higher lateral and vertical permeabilities. This model would allow for a greater volume of groundwater to move downgradient through the shallow system to supply

the quantity of water measured near the mouth of the Metro Storm Drain without relying on significant upward discharge of the deeper groundwater system in the area.

22. Page 3-26, last paragraph: Water level data at Well TS-01 do not "exhibit fluctuations similar to those recorded at wells next to Silver Bow Creek" in all instances. For example, April 1985 data for Well GS-03 indicate that the water table rose, then fell. Data for Well TS-01 indicate a continued rise throughout the month. Also, diurnal fluctuations should be explained, as they can be significant at this location (e.g., Well GS-04 exhibited a 0.2-ft diurnal variation in February).

    Response: Review of water level data for April, 1985 at monitoring wells TS-01 and GS-03 does not indicate trends you suggest. Continuous water level records at well TS-01 indicate relatively consistent groundwater elevations from April 1 through April 9. A gradual rise in groundwater elevation was measured from April 9 through about April 20, followed by declining groundwater elevations to the end of the month. Continuous water level records from monitoring well GS-03 for the same time period indicate a sharp rise in groundwater elevation occurred on April 2, followed by declining groundwater levels to April 6. Minimal change occurred in the groundwater elevation at GS-03 throughout the duration of the month.

    The intent of the statement at the bottom of page 3-26 is to suggest that temporal changes in groundwater elevations in the alluvial aquifer are relatively similar between monitoring wells located proximal and distal to Silver Bow Creek. Because water table fluctuations in a sand and gravel aquifer are dynamic in response to recharge areas and rates, it is expected that water level trends between two individual wells for a specific time period may not track exactly.

Diurnal variations in the continuous water level data from monitoring wells located adjacent to Silver Bow Creek are best explained by the variability in stage in Silver Bow Creek caused by freeze-thaw conditions common in the Butte area during spring snowmelt. This relationship also indicates that the surface water and groundwater systems are interrelated and in communication with each other.

Alternatively, some apparent diurnal variations in continuous groundwater level data may be a function of the float cable associated with the recorder which may be expanding and contracting with temperature variations; although this could impart only a minimal change 10(001-0.01 ft).

23. Page 3-28, first sentence: The data alluded to in the report that were used to draw this conclusions should be referenced. The conclusion can not be verified independently from the data in the report.

    Response: Data evaluated to generate this statement include groundwater level data for DW-500 series wells (Appendix B, Part 3, Attachment V-A) shown on Map 1-5 (Oversize). Analysis of temporal variability was not meaningful because static water level measurements were completed only once or twice at these wells. Analysis of spatial variability was not prudent owing to the lack of survey data to tie measuring point elevations together and because of the variability of completion depths of the wells.

24. Page 3-29, second paragraph: According to well logs on pages III-10 and III-17, the bottom of Well GS-10A is 6 ft above the top of the sand pack in Well GS-07. The top of the sand pack, not the screened interval, is the upward boundary of the pumped interval. The distance should then be 6 ft not 25 ft. It is difficult to believe that a well 6 ft vertically and 10 ft horizontally away would not be affected, especially without firm geologic evidence to support the presence of an aquiclude or aquitard. The log of Well GS-07

indicates water-yielding material in the interval between the two wells. A possible explanation for the lack of response is that Well GS-10A is clogged.

<u>Response</u>: The top of the sand pack in well GS-07 is at 120 feet while the bottom of the sand pack in well GS-10A is at 110 feet, a vertical separation of ten feet, not six feet. Nevertheless, the minimal reaction measured in well GS-10A during the pumping test conducted at well GS-07 appeared, at first, anomolous. Monitoring well GS-10A is probably not clogged, as is indicated on the well development log (Appendix B, Part 2, Attachment III-B). Well GS-10A produced approximately 5 gpm during development, an appreciable yield for a two-inch well with a ten foot perforated interval. The calculated transmissivity for GS-07 is 300 gpd/ft, inferring a hydraulic conductivity of 10 gpd/ft^2, assuming the perforated interval is the saturated thickness. Using a vertical vs. horizontal permeability of 0.1 (common to alluvial aquifers), the vertical permeability is on the order of 1 gpd/ft^2. This value is extremely low and may explain the slight reaction. Also, from the well log for GS-07, the interval from 113 to 118 feet is composed of silty clayey sand, a lithology typically not considered to be a significant water-yielding zone.

25. Page 3-29, last paragraph: Single borehole aquifer tests generally produce lower quality data for the determination of hydraulic properties because of formation damage and reduced well efficiency. These weaknesses must be brought out in the text.

<u>Response</u>: It is true that single borehole aquifer tests do not produce data of the quality provided by tests conducted with a pumping well and several observation wells completed at similar depths. The weaknesses of the single borehole test are well-documented in the scientific literature; however, what the tests do provide is a relative indication of such hydraulic parameters as

transmissivity, hydraulic conductivity, and specific yield. It is unlikely that elaborate pumping test schemes would result in such different values for these parameters to alter the conclusion that the deeper water-bearing units in this area exhibit low horizontal permeabilities and even lower vertical permeabilities.

26. Page 3-32, second paragraph: To verify the flow calculation, the formula (assumed to be Darcy's Law) and values used for variables in the formula should be provided or referenced.

<u>Response</u>: The value of 1500 gpd was calculated using a version of Darcy's Law where:

Quantity = Transmissivity x Gradient x Width

where: Transmissivity = 5000 gpd/ft
Gradient = .003
Width = 100 ft

Another appropriate calculation may be to use a modification of Darcy's Law for unconfined flow where:

$$\frac{Q}{W} = \frac{K}{2L}\left(H_1^2 - H_2^2\right)$$

using: $K = 500$ gpd/ft^2
$H_1 = 14.3$ ft
$H_2 = 14$ ft
$L = 100$ ft
$W = 100$ ft

This calculation results in a total groundwater flux of 2120 gallons per day through this area.

27. Page 3-32, third paragraph: Water table aquifers respond like artesian aquifers if pumped for a time period long enough to remove the effects of delayed drainage. However, data plots indicate positive boundaries (perhaps delayed drainage), and aquifer variables calculated from those data by using analytical techniques for artesian conditions would be erroneous. Three hours are probably not sufficient to remove these effects, as evidenced by the presence of positive boundaries. Two alternative explanations for a lack of response are insufficient pumping time and a plugged observation well. The result of an insufficient pumping period or a plugged observation well is an inaccurate estimate of aquifer parameters that will be used as part of the remedial design.

Response: Confined aquifer techniques may not be appropriate for analyzing the aquifer tests conducted in presumably unconfined aquifers. As stated earlier, the straight line plots were presented because of their visual representation of the pumping data.

Monitoring wells installed along Silver Bow Creek from Rocker to Miles Crossing were intended to provide access for groundwater quality sampling, water level measurement, lithologic characterization, and to characterize general aquifer parameters, as specified in the project work plan (MultiTech, 1984a, Section 2.1.3). The two well clusters (GS-01, GS-02, and GS-03, GS-04) were not designed to provide complete aquifer hydraulic characterization. Shallow wells in each well cluster were completed in tailings deposits. These shallow wells were dry or nearly dry throughout the duration of the study. Consequently, the resulting aquifer tests are essentially single well tests, from which aquifer parameters such as storage could not be calculated.

It is assumed the possible delayed yield effects you are referring to are for well GS-01. The drawdown curve presented does not appear to represent delayed yield because the curve break at 40 minutes seems to be too sharp to represent these effects. While pumping well

GS-01, the discharge rate occasionally varied; specifically, the discharge rate slightly decreased at ten minutes into the test and increased measurably at approximately 40 minutes. The slightly varying pumping rates better explain the inflection points than do the possible effects of delayed yield from storage. Flattening of the drawdown curve could also be attributed to recharge from Silver Bow Creek, located approximately 15 feet from the pumping well.

It is possible that well GS-02 is plugged, because well development was difficult due to the limited amount of standing water in the borehole (approximately 2 feet). Also, water in the well did not clear up during development probably due to the silty nature of the material in which the well was completed. The lack of response may be due to a plugged well, but it may be equally likely that the well did not respond due to poor aquifer connection, or a combination of both. These difficulties in completion precluded the use of GS-02 as an observation well for pumping well GS-01, and any hydraulic parameters that were established are based on single well tests. Therefore, the difficulty experienced with well GS-02 does not affect hydraulic parameters derived from pumping well GS-01.

28. Page 3-32, last paragraph: The calculation of the values of hydraulic conductivity are not contained in the text or in the appendix. The calculations should be documented in the report.

Response: Hydraulic conductivity values were calculated by definition:

$$K = T/b$$

where:

K = Hydraulic Conductivity
T = Transmissivity
b = Saturated Aquifer Thickness

The range of hydraulic conductivity values calculated (500-900 gpd/ft^2) were calculated using the following values:

Low range: $T = $ 7,300 gpd/ft (GS-03, recovery)
$b = $ 15 feet (GS-03, high groundwater)

High range: $T = $ 10,000 gpd/ft^2 (GS-03, drawdown)
$b = $ 11 feet (GS-03, low groundwater)

29. Page 3-33, first paragraph: Field data sheets for Wells TS-03, TS-04, and TS-05 are not contained in Appendix V. The last sentence indicates that the east-west isotropy is greater than the north-south isotropy. This statement may not be true. The hydraulic conductivity tensor to the west may be greater or less than that to the east. Also, the tensor to the north is unmeasured and may be greater than the tensor to the west. The test results indicate that the western tensor of hydraulic conductivity is greater than the southern tensor. Remedial design based upon the statement in the text may assume erroneous groundwater flow paths.

<u>Response</u>: Field data sheets for wells TS-03, TS-04, and TS-05 are included as Attachment B-1 of this document. Referring to Map 2-5, observation wells are located west (TS-03, TS-04) and south (TS-05) of pumping well TS-01. Wells TS-02, TS-06, and TS-07 are shallow wells completed in tailings deposits that were dry or nearly dry during the tests and thus did not provide viable observation points. The intent of statement contained in the text was not to address tensor relationships, but rather directional trends in observed isotropy.

Observation well TS-05 realized more drawdown than did well TS-03, even though the well is located farther away from the pumping well. This observation indicates permeabilities trending north-south are greater than those trending east-west.

30. Page 3-44, first paragraph: Other potential sources of contamination are landfills, the sewage treatment plant, and naturally occurring ore bodies.

Response: Potential sources of contamination to the groundwater system within the Silver Bow Creek CERCLA site include those AMC describes. The significance and desirability of evaluating these potential sources will be addressed during future remedial investigations of various operable units in the study area.

31. Page 3-45, Map 3-6: Indicating the concentrations of each contaminant on this map or a series of maps would be more definitive. This map does not allow for any independent evaluation.

Response: Isopleth maps showing the variability of concentrations of selected parameters are included as Attachment B-2 to this response document.

32. Page 3-47, Line 1: What is the basis of stating groundwater quality is degraded? Supporting data on well numbers, locations, and concentrations should be provided.

Response: See response to Comment 31. Measured concentrations are lower than in both upgradient monitoring wells (located east of the Metro Storm Drain area), and with respect to MCLs established by the USEPA.

33. Page 3-47, Line 14: What variables were measured? Is the level of elevation relative to a standard, a background, or to zero? "Extremely elevated" provides no quantification of the situation.

Response: Variables measured in assessing contamination levels include dissolved fractions of cadmium, copper, iron, lead, zinc, and sulfate. Concentrations of these parameters are elevated with respect to established MCLs (cadmium and lead) and with respect to

upgradient groundwater quality (as measured in monitoring wells located east of the Metro Storm Drain area, in the Blacktail Creek alluvial system, and upgradient wells completed adjacent to this area). Also, please review Attachment B-2 associated with response to Comment 31.

34. Page 3-48, Line 11: Two other alternatives for improved quality with depth are an upward hydraulic gradient or adsorption onto soils.

Response: The two mechanisms you describe are viable in explaining improving groundwater quality with depth in this area. Evaluation of these mechanisms may be an appropriate task during future RIs at this site.

35. Page 3-49, Line 5: Quantify and qualify what constitutes a "significant" source. Significant is a relative term. Also, provide a basis for such statements.

Response: "Significant" is a relative term. The intent of the sentence is to indicate that chemical analyses of material samples collected from within the Parrot Tailings (see Appendix B, Part 4, Attachment VI-C) and of groundwater samples collected from shallow monitoring wells in the vicinity of the Parrot Tailings (data from monitoring well DW-105, Appendix B, Part 4, Attachment VI-A) demonstrate that metals (including copper, zinc, iron, manganese, cadmium, and lead) are elevated when compared to subjacent soils data and upgradient groundwater data. Significance in this case represents a ten-fold elevation factor for metals in soils, as compared to subjacent soils material, and a hundred-fold elevation factor for certain metals concentrations in groundwater, as compared to background.

36. Page 3-51, Line 11: This statement is based on no substantial information. Substitution of "possibly" for "likely" is suggested since the extent of contamination is unknown.

Response: The dewatering well associated with the Butte Sewage Treatment Plant is located directly downgradient from the historic Butte Reduction Works tailings impoundments. Further characterization of the sources and extent of contamination in this area may be an appropriate task for additional remedial investigations.

37. Page 3-115, Line 13: Operational procedures affect the recharge rate and do not control the mechanism of groundwater mounding. Groundwater mounding is controlled by recharge rate, time, and specific yield. The recharge rate is influenced by operational procedures implemented at the concentrator.

Response: AMC's view on the mechanics of groundwater movement is correct. The intent of the paragraph is to conceptualize mechanisms not evaluated during the RI which would explain gathered data. The premise is that operational procedures employed at the Weed Concentrator, which involves discharges from the facility into the Metro Storm Drain, serve to recharge the underlying groundwater system and cause an increase in the elevation of the shallow groundwater system. If the recharge rate to the underlying groundwater system is of sufficient magnitude that the existing groundwater system cannot accommodate increased inflow, groundwater mounding may occur. Mounding will locally increase the elevation of the groundwater system, possibly saturating a greater thickness of the Parrot Tailings and releasing more metals to the groundwater system. Alternatively, leakage through the Metro Storm Drain, supplied with water from discharges from the Weed Concentrator complex, could serve to leach metals from oxidized zones within the Parrot Tailings and generate greater metals loading to the subjacent groundwater system.

38. Page 4-6, Contaminant Sources: Are other sources of contamination possible? If so, they should be listed, and a note made that the scope of this investigation did not include them.

Response: Other sources of groundwater contamination within the study area are possible. A list of potential sources other than those described would be subjective and probably inappropriate, given the level of knowledge of the site. Sources described in the RI include those for which some data and level of confidence are possible to identify locations and mechanisms for contaminant transport. Other possible sources of groundwater contamination may be evaluated in detail (if warranted) during future RI activities.

39. Page IV-4: A reference to field operation procedures would be helpful to document how decontamination was performed.

Response: Field operations procedures used during the RI are presented in the project quality assurance plan (Table 3.3 of the Remedial Investigation Quality Assurance Plan) and in the project work plan (MultiTech, 1984a, Section 4.4.5).

40. Pages V-112 and V-113: The record of water levels for March is missing for Well GS-04.

Response: Groundwater in monitoring well GS-04 was frozen during March; a temporal record of these unusable data was intentionally omitted from the Phase I RI report.

41. Pages V-182 through V-184: Data sheets appear to be missing or mixed. For example, test dates are shown as 6/26/85 (p.182), 9/26/85 (p.183), and 6/27/85 (p.184). There are no readings after 26 minutes on the 6/26 data and no data before 240 minutes on the 9/26 data.

Response: These pages were inadvertently omitted and are contained in Attachment B-3 to this response document.

42. Page V-188: This page makes no sense. What is Case #2? What method is used? The variables should be defined.

Response: Case #2 represents the analyst's selection of a different time step in the recovery data to evaluate transmissivity in well using a method described by Skibitzke (1958). The calculations shown are to allow for a comparison to Case #1, presented on the previous page.

43. Page V-191: It is not clear that a reliable transmissivity can be calculated based upon this analysis. This graph and the next illustrate the problem associated with single borehole tests. Based on the plot on page V-192, the theoretical drawdown at the pumped well is approximately 3 ft. The measured value is approximately 10 ft. This is a 30-percent well efficiency. Such an error will cause an underestimate of transmissivity. The efficiency also indicates poor well development, which may account for the poor response in observation wells.

    Response: Drawdown in well TS-01 was significant due to well loss. Consequently, the distance drawdown plot on page V-192 was presented because the effects of well loss on an observation well are negligible. Ranges of permeabilities calculated from aquifer tests did not include those using transmissivity values calculated for well TS-01.

44. Page V-192: There should be a calculation of the storage coefficient (a standard aquifer parameter). Proof of the validity of the Jacob method should be shown. The pumped well should be noted. Why are no time drawdown plots shown for observation Wells TS-03 and TS-04? The distance should be "1 foot" not "0 foot" as shown.

    Response: The storage coefficient and corrections to the distance drawdown plot are included as Attachment B-4 to this document. Also included in Attachment B-4 is a log-log plot of observation well TS-04. The curve resulting from distance-drawdown analyses indicates the effects of delayed yield. However, the transmissivity calculated

using delayed yield type-curves is in close agreement with that calculated using the distance-drawdown method. Time-drawdown data for well TS-03 were not presented owing to its quick response and the lack of early data, making type-curve matching inappropriate.

45. Page V-193: This plot is an example of possible delayed drainage effects, which would have been more properly analyzed on a log-log plot.

Response: A log-log plot of pumping data for well GS-01 is included as Attachment B-5 to this document. Type-curve matching techniques using Boulton or Stallman methods are inappropriate because of the lack of observation wells associated with the test site. Another explanation for the observed flattening of the presented curve is the boundary effect caused by the presence of Silver Bow Creek.

46. Pages V-194-195: These plots are examples of boundary effects that are not discussed in the text. Boundary conditions are an important element of understanding the dynamics of the groundwater flow system and thus of one of the two major pathways for the contaminants.

Response: As described previously, pumping rates varied slightly throughout the tests, and these phenomena may have influenced the curves to some degree. However, drawdown plots of wells GS-01 and GS-03 most likely indicate recharge from Silver Bow Creek, resulting in the observed boundary condition.

REFERENCES CITED

RESPONSES TO APPENDIX B COMMENTS

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MultiTech, 1984a. Silver Bow Creek Remedial Investigation Work Plan. For the Montana Department of Health and Environmental Sciences, Helena, Montana.

MultiTech, 1984b. Silver Bow Creek Preliminary Technology Review. For the Montana Department of Health and Environmental Sciences, Helena, Montana.

Skibitzke, H., 1958. An Equation for Potential Distribution about a Well Being Bailed; U.S.Geological Survey Open File Report.

Walton, W., 1987. Groundwater Pumping Tests; Design and Analysis. Lewis Publishers, Chelsea, Michigan.

ATTACHMENT

B-1

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED (Data Reported on This Form) TS-02
WELL TESTED TS-01
TEST DATE 6/26/85

Project SBC-CERCLA Personnel TR. - P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 1/2" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5' - 26.5'

Desc. of MP TOP OF WELL PROTECTOR Stick-up(ft) +2.15 SWL below MP(ft) 9.63 SWL below GS(ft) 7.48'

Aquifer Name SBC-ALLUVIUM Aquifer Description (Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)

Distance of Observation Well from Pumping Well(ft) 10 Pump hp. & type Pump Depth(ft)

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) Temp(°C) Time

Avg. Discharge(gpm) 28 Test Duration(min) Max WL Change(ft) Transmissivity (gpd/ft)

Storativity Hydraulic Conductivity(gpd/ft²) Specific Capacity(gpm/ft of drawdown) 3.02

REMARKS 100 PSI TRANSDUCER · ZERO OFFSET = (0.04); SENSITIVITY = (1.00)
GPM = 2(3.1259·√h) h = MANOMETER READING

Date & hour 6-26-85	Time	TRANSDUCER READING	BAROMETER (In)	MANOMETER (In)	HEAD (ft)	DRAWDOWN (ft)	T/r²	
1730	0	5.66	30.24	15"	14.30	0		
1731.5	1.5	4.84	30.23		13.37	0.93	1x10⁻⁵	
1732.5	2.5	4.81	30.23		13.34	0.96	1.7x10⁻⁵	
1733.5	3.5	4.81	30.23		13.34	0.96	2.4x10⁻⁵	
1734.5	4.5	4.80	30.23		13.33	0.97	3.1x10⁻⁵	
1736.5	6.5	4.79	30.24		13.31	0.99	4.5x10⁻⁵	
1738	8.0	4.79	30.24		13.31	0.99	5.4x10⁻⁵	
1739.5	9.5		30.24	12½"	13.31	0.99	6.6x10⁻⁵	
1740	10.0	4.74	30.24	15"	13.35	1.05	6.9x10⁻⁵	
1741.5	11.0	4.76	30.24	16"	13.27	1.03	7.6x10⁻⁵	
1743.5	13.5	4.77	30.24		13.28	1.02		
1745.5	15.5	4.78	30.25		13.28	1.02	1.08x10⁻⁴	
1748	18.0	4.74	30.25	16"	13.24	1.06	1.25x10⁻⁴	
1751	21.0	4.76	30.26	17"	13.25	1.05		
1753	23.0	4.75	30.27		13.23	1.07		
1755	25.0	4.69	30.27		13.16	1.14		
1803	33.0	4.72	30.27		13.19	1.11	2.29x10⁻⁴	
1806.5	36.5	4.73	30.28		13.19	1.11		
1809	39.0	4.72	30.29		13.17	1.13		
1811	41	4.72	30.29		13.17	1.13		
1814	44	4.72	30.29		13.17	1.13		
1816	46	4.72	30.29		13.17	1.13		
1821	51	4.72	30.29	17"	13.17	1.13		
1827	57	4.72	30.29		13.17	1.13		

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED TS-03
(Data Reported On This Form)

WELL TESTED TS-01

Project SBC · CERCLA Personnel T.R. - P.D. TEST DATE 6-26-85, 6-27-85

Date & hour	Time	TRANSDUCER READINGS	BAROMETER (IN)	MANOMETER IN"	HEAD (ft)	DRAWDOWN (ft)		
1831.5	61.5	4.72	30.29	20"	13.17	1.13		
1840	70	4.60		20.5"	13.03	1.27		
1844.5	74.5	4.64		20"	13.08	1.22		
1846	76	4.65			13.09	1.21	5.28×10^{-4}	
1848	78	4.64	30.29		13.08	1.22		
1853	83	4.67	30.30	20"	13.10	1.20		
1857	87	4.65	30.30	20"	13.08	1.22		
1900	90	4.64	30.29		13.08	1.22		
1910	100	4.64			13.08	1.22		
1926	116	4.64			13.08	1.22		
1935	125	4.59	30.30	20"	13.01	1.29		
1937	127	4.60		20"	13.02	1.28	5.28×10^{-4}	
1950	140	4.59			13.01	1.29		
2000	150	4.59			13.01	1.29		
2010	160	4.58			13.00	1.30		
2022	172	4.58			13.00	1.30		
2030	180	4.58			13.00	1.30	1.25×10^{-3}	
2040	190	4.58	30.31	20"	12.99	1.31		
2050	200	4.58			12.99	1.31		
2100	210	4.58			12.99	1.31		
2110	220	4.58			12.99	1.31		
2120	230	4.58	30.32		12.98	1.32	1.60×10^{-3}	
2130	240	4.57			12.96	1.34		
2215	285	4.61	30.34		12.99	1.31		
2230	300	4.61	30.36		12.96	1.34		
2240	310	4.61	30.35	20"	12.98	1.32		
2250	320	4.61			12.98	1.32	2.22×10^{-3}	
2300	330	4.61			12.98	1.32		
2310	340	4.60	30.34		12.98	1.32		
2320	350	4.60			12.98	1.32		
6-27-85 0020	410	4.61			12.99	1.31		
0045	435	4.60	30.35	20"	12.96	1.34		
0100	450	4.61	30.36	20"	12.96	1.34		
0200	510	4.62	30.35		12.99	1.31		
0300	570	4.61	30.34	20"	12.99	1.31		
0400	630	4.62	30.31		13.03	1.27		
0500	690	4.61	30.28	20"	13.05	1.25	4.8×10^{-3}	

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-03
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 6-27-85

Project SBC- CERCLA Personnel T.R. - P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5' - 26.5'

Desc. of MP TOP OF WELL PROTECTOR Stick-up(ft) 2.15 SWL below MP(ft) 9.63' SWL below GS(ft) 7.48'

Aquifer Name SBC - ALLUVIUM Aquifer Description
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)

Distance of Observation Well from Pumping Well(ft) 10' Pump hp. & type Pump Depth(ft)

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) Temp(°C) Time

Avg. Discharge(gpm) 28 Test Duration(min) Max WL Change(ft) Transmissivity (gpd/ft)

Storativity Hydraulic Conductivity(gpd/ft²) Specific Capacity(gpm/ft of drawdown)

REMARKS

Date & hour	Time	TRANSDUCER READING	BAROMETER (IN)	MANOMETER (IN)	HEAD (ft)	DRAWDOWN (ft)		
0600	750	4.62	30.28	20"	13.07	1.23		
0700	810	4.59	30.34		12.96	1.34		
0800	870	4.59	30.36	20"	12.94	1.36		
0900	930	4.60	30.33		12.99	1.31		
1000	990	4.60	30.31		13.01	1.29		
1100	1050	4.59	30.30		13.01	1.29		
1200	1110	4.58	30.30		13.00	1.30		
1400	1230	4.57	30.25		13.04	1.26		
1540	1330	4.58	30.20	20"	13.11	1.19		
1722	1432	4.55	30.21		13.07	1.23		
1730	1440	4.55	30.21		13.07	1.23		

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-03
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 6-27-85

Project SBC-CERCLA Personnel TR.-P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5'-26.5'

Desc. of MP TOP OF WELL PROTECTOR Stick-up(ft) ±2.15 SWL below MP(ft) 9.603 SWL below GS(ft) 7.47

Aquifer Name SBC ALLUVIUM Aquifer Description
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)

Distance of Observation Well from Pumping Well(ft) 10' Pump hp. & type Pump Depth(ft)

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) Temp(°C) Time

Avg. Discharge(gpm) 28 Test Duration(min) Max WL Change(ft) Transmissivity (gpd/ft)

Storativity Hydraulic Conductivity(gpd/ft²) Specific Capacity(gpm/ft of drawdown)

REMARKS

Date & hour	Time t	t'	TRANSDUCER READING	BAROMETER (IN)	HEAD (ft)	RESIDUAL DRAWDOWN	t/t'	
1730	1440	0	4.55	30.21	13.07	1.23		
1731	1441	1	4.58		13.10	1.20	1441	
1733	1443	3	5.62		14.28	0.02	481	
1734	1444	4	5.62		14.28	0.02	361	
1735	1445	5	5.63		14.30	0.00	289	
1737	1447	7	5.63	30.21	14.30	0.00	207	
1739	1449	9	5.64	30.22	14.30	0.00	161	
1741	1451	11	5.64	30.23	14.28	0.02	132	
1745	1455	15	5.64		14.26	0.04	97	
1750	1460	20	5.65	30.23	14.30	0.00	73	
1758	1468	28	5.65		14.30	0.00	52	
1800	1470	30	5.65	30.23	14.30	0.00	49	
1805	1475	35	5.65	30.22	14.31	-0.01	42	
1810	1480	40	5.65	30.23	14.30	0.00	37	
1946	1576	136	5.65	30.23	14.30	0.00	12	
2037	1627	187	5.66	30.24	14.30	0.00	9	

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-04
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 6-26-85, 6-27-85

Project SBC-CERCLA Personnel TR. P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5-26.5'

Desc. of MP TOP OF WELL PROTECTOR Stick-up(ft)___ SWL below MP(ft) 9.42' SWL below GS(ft)___

Aquifer Name SBC-ALLUVIUM Aquifer Description___
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)___

Distance of Observation Well from Pumping Well(ft) 39' Pump hp. & type 1HP Pump Depth(ft)___

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C)___ Temp(°C)___ Time___

Avg. Discharge(gpm)___ Test Duration(min)___ Max WL Change(ft)___ Transmissivity (gpd/ft)___

Storativity___ Hydraulic Conductivity(gpd/ft²)___ Specific Capacity(gpm/ft of drawdown)___

REMARKS MEASURED WITH ELECTRIC M-SCOPE

Date & hour 6-26-85	Time	S.W.L (ft)	DRAWDOWN (ft)	r^2/T	T/r^2	τ(days)		
1730	0.0	9.42	0					
1730.45	0.45	9.48	0.06					
1735	5.0	9.58	0.16	4.38×10^5	2.28×10^{-6}	.003472		
1759	29.0	9.65	0.23	7.55×10^4	1.32×10^{-5}			
1806	36	9.74	0.32	6.08×10^4	1.64×10^{-5}			
1809.5	39.5	9.65	0.23	5.54×10^4	1.80×10^{-5}			
1813	43	9.65	0.23	5.09×10^4	1.96×10^{-5}			
1817	47	9.65	0.23	4.66×10^4	2.15×10^{-5}			
1825	55	9.65	0.23	3.98×10^4	2.51×10^{-5}			
1849	79	9.65	0.23	2.77×10^4	3.61×10^{-5}			
1858	88	9.68	0.26	2.49×10^4	4.02×10^{-5}			
1910	100	9.68	0.26	2.19×10^4	4.57×10^{-5}			
1927	117	9.68	0.26	1.87×10^4	5.34×10^{-5}			
1928	118	9.68	0.26	1.86×10^4	5.39×10^{-5}			
1951	141	9.68	0.26	1.55×10^4	6.44×10^{-5}			
2000	150	9.68	0.26	1.46×10^4	6.85×10^{-5}			
2012	162	9.68	0.26	1.35×10^4	7.40×10^{-5}			
2021	171	9.68	0.26	1.28×10^4	7.81×10^{-5}			
2032	182	9.70	0.28	1.20×10^4	8.31×10^{-5}			
2041	191	9.68	0.26	1.14×10^4	8.72×10^{-5}			
2051	201	9.69	0.27	1.09×10^4	9.18×10^{-5}			
2101	211	9.70	0.28	1.04×10^4	9.63×10^{-5}			
2111	221	9.69	0.27	9.91×10^3	1.01×10^{-4}			
2122	232	9.69	0.27	9.44×10^3	1.06×10^{-4}			

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED TS-04
(Data Reported On This Form)

WELL TESTED TS-01

Project SBC-CERCLA Personnel T.R. - P.D. TEST DATE 6-26, 6-27-85

Date & hour	Time	S.W.L. (ft)	DRAWDOWN (ft)	r^2/T	T/r^2			
2131	241	9.69	0.27	9.09×10^3	1.1×10^{-4}			
2222	292	9.69	0.27	7.50×10^3	1.33×10^{-4}			
2251	321	9.69	0.27	6.82×10^3	1.47×10^{-4}			
6-27-85 0020	410	9.69	0.27	5.34×10^3	1.87×10^{-4}			
0045	435	9.69	0.27	5.04×10^3	1.99×10^{-4}			
0200	510	9.69	0.27	4.29×10^3	2.33×10^{-4}			
0312	582	9.69	0.27	3.76×10^3	2.66×10^{-4}			
0401	631	9.68	0.26	3.47×10^3	2.88×10^{-4}			
0503	693	9.68	0.26	3.16×10^3	3.16×10^{-4}			
0602	752	9.69	0.27	2.91×10^3	3.43×10^{-4}			
0701	810	9.70	0.28	2.70×10^3	3.70×10^{-4}			
0810	880	9.69	0.27	2.49×10^3	4.02×10^{-4}			
0938	968	9.67	0.25	2.26×10^3	4.42×10^{-4}			
1148	1098	9.68	0.26	1.99×10^3	5.01×10^{-4}			
1408	1238	9.70	0.28	1.77×10^3	5.65×10^{-4}			
1530	1320	9.70	0.28	1.66×10^3	6.03×10^{-4}			
1723	1433	9.70	0.28	1.53×10^3	6.54×10^{-4}			

AQUIFER TEST DATA

DAVID STILLER AND ASSOCIATES
HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS - 05
(Data Reported on This Form)

WELL TESTED TS - 01

TEST DATE 6-26-85, 6-27-85

Project SBC - CERCLA Personnel T.R. - P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5 - 26.5'

Desc. of MP ______ Stick-up(ft) ______ SWL below MP(ft) 9.75' SWL below GS(ft) ______

Aquifer Name SBC - ALLUVIUM Aquifer Description ______
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ______

Distance of Observation Well from Pumping Well(ft) 20 Pump hp. & type ______ Pump Depth(ft) ______

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ______ Temp(°C) ______ Time ______

Avg. Discharge(gpm) ______ Test Duration(min) ______ Max WL Change(ft) ______ Transmissivity (gpd/ft) ______

Storativity ______ Hydraulic Conductivity(gpd/ft^2) ______ Specific Capacity(gpm/ft of drawdown) ______

REMARKS MEASURED WITH ELECTRICAL M-SCOPE

Date & hour	Time T	S.W.L. (ft)	DRAWDOWN (ft)	r^2/t				
1730	0	9.75	0					
1731	1	10.99	1.24	5.70×10^{5}				
1736	6	11.10	1.35	9.60×10^{4}				
1758	28	11.11	1.36	2.06×10^{4}				
1807	37	11.15	1.40	1.56×10^{4}				
1811	41	11.16	1.41	1.40×10^{4}				
1813.5	43.5	11.20	1.45	1.32×10^{4}				
1818	48	11.18	1.43	1.20×10^{4}				
1825	55	11.18	1.43	1.05×10^{4}	—			
1850	80	11.29	1.54	7.2×10^{3}				
1859	89	11.31	1.56	6.47×10^{-3}				
1911	101	11.31	1.56	5.70×10^{-3}				
1927	117	11.31	1.56	4.92×10^{-3}				
1940	130	11.40	1.65	4.43×10^{3}				
1951	141	11.40	1.65	4.09×10^{3}				
2000	150	11.40	1.65	3.84×10^{3}				
2012	162	11.41	1.66	3.56×10^{3}				
2021	171	11.41	1.66	3.37×10^{3}				
2032	182	11.41	1.66	3.16×10^{3}				
2041	191	11.41	1.66	3.02×10^{3}				
2051	201	11.41	1.66	2.87×10^{3}				
2101	211	11.39	1.64	2.73×10^{3}				
2111	221	11.40	1.65	2.61×10^{3}				
2122	232	11.40	1.65	2.48×10^{3}				

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED TS-05
(Data Reported On This Form)

WELL TESTED TS-01

Project SBC-CERCLA Personnel TR.-P.D. TEST DATE 6-26 6-27-85

Date & hour	Time	S.W.L. (ft)	Drawdown (ft)	T_2/T_1				
21.31	241	11.38	1.63	2.39×10^{3}				
22.22	292	11.39	1.64	1.97×10^{3}				
2251	321	11.39	1.64	1.79×10^{3}				
6-27-85 0020	410	11.41	1.66	1.40×10^{3}				
0045	435	11.38	1.63	1.32×10^{3}				
0200	510	11.39	1.64	1.13×10^{3}				
0312	582	11.39	1.64	9.89×10^{2}				
0401	631	11.40	1.65	9.12×10^{2}				
0503	693	11.41	1.66	8.31×10^{3}				
0602	752	11.43	1.68	7.65×10^{2}				
0701	811	11.44	1.69	7.10×10^{2}				
0810	880	11.43	1.68	6.54×10^{2}				
0938	968	11.40	1.65	5.95×10^{2}				
1149	1199	11.44	1.69	4.80×10^{2}				
1408	1238	11.42	1.67	4.65×10^{2}				
1530	1320	11.42	1.67	4.36×10^{-2}				
1723	1427	11.43	1.68	4.03×10^{-2}				

AQUIFER TEST DATA

DAVID STILLER AND ASSOCIATES
HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-05
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 6-27-85

Project SBC - CERCLA Personnel TR. - D.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 2" Well Depth(ft) 27' Perforated Zone(s)(ft) 16.5' - 26.5'

Desc. of MP TOP OF WELL PROTECTOR Stick-up(ft) ______ SWL below MP(ft) 9.75 SWL below GS(ft) ______

Aquifer Name SBC - ALLUVIUM Aquifer Description ______
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ______

Distance of Observation Well from Pumping Well(ft) 20' Pump hp. & type ______ Pump Depth(ft) ______

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) ______ Temp(°C) ______ Time ______

Avg. Discharge(gpm) ______ Test Duration(min) ______ Max WL Change(ft) ______ Transmissivity (gpd/ft) ______

Storativity ______ Hydraulic Conductivity(gpd/ft²) ______ Specific Capacity(gpm/ft of drawdown) ______

REMARKS ______

Date & hour 6-27-85	Time t	t'	t/t'	S.W.L. (ft)	RESIDUAL DRAWDOWN			
1735	1445	5	289	9.82	0.07			
1738.5	1448.5	8.5	170	9.80	0.05			
1741.5	1451.5	11.5	126	9.77	0.02			
1750.5	1460.5	20.5	71	9.77	0.02			
1754	1464	24	61	9.76	0.01			
1825	1495	55	27	9.76	0.01			
1948	1578	138	11	9.76	0.01			
2043	1633	193	8.5	9.79	0.04			

ATTACHMENT B-2

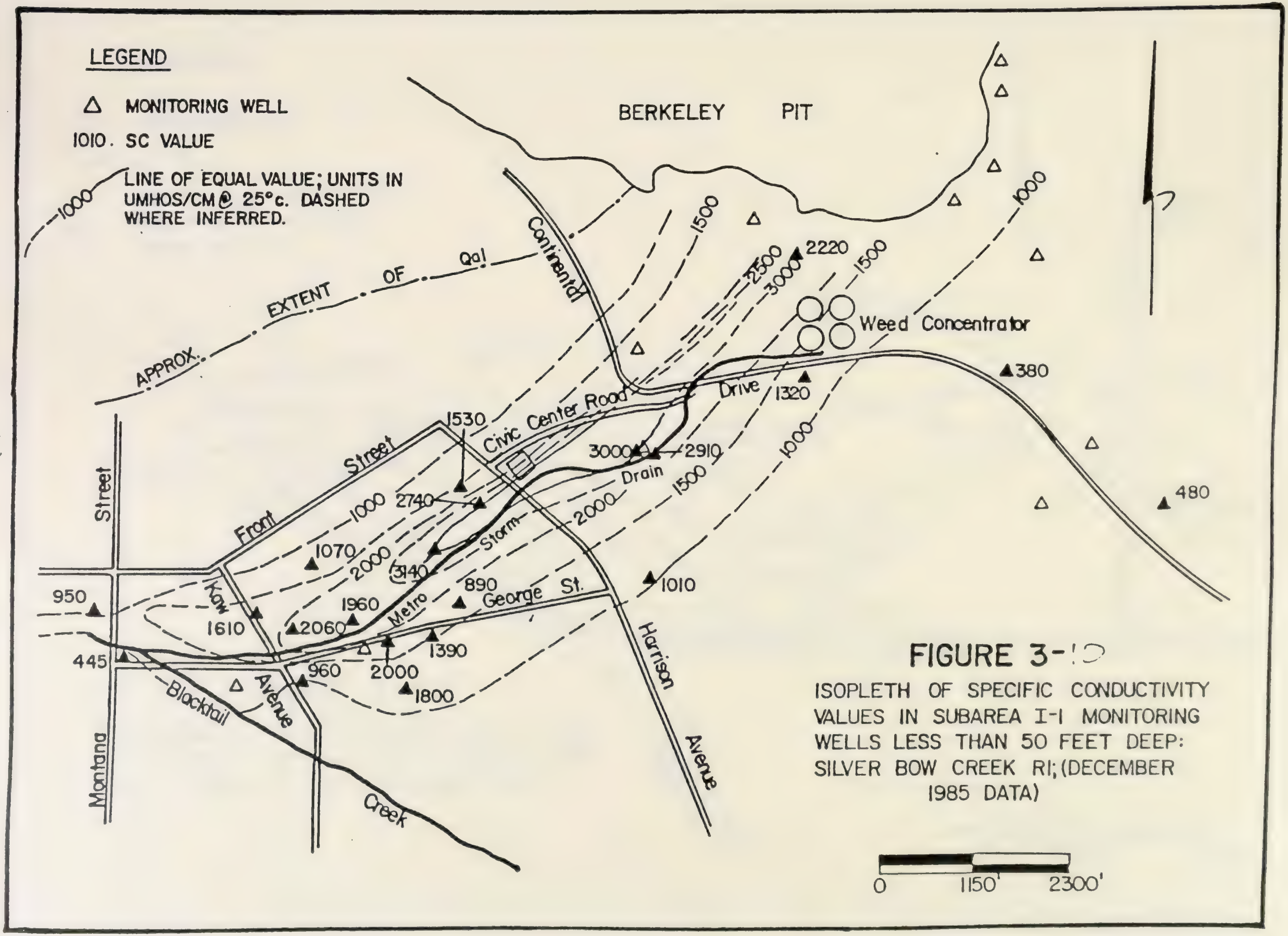


FIGURE 3-10

ISOPLETH OF SPECIFIC CONDUCTIVITY VALUES IN SUBAREA I-1 MONITORING WELLS LESS THAN 50 FEET DEEP: SILVER BOW CREEK RI; (DECEMBER 1985 DATA)

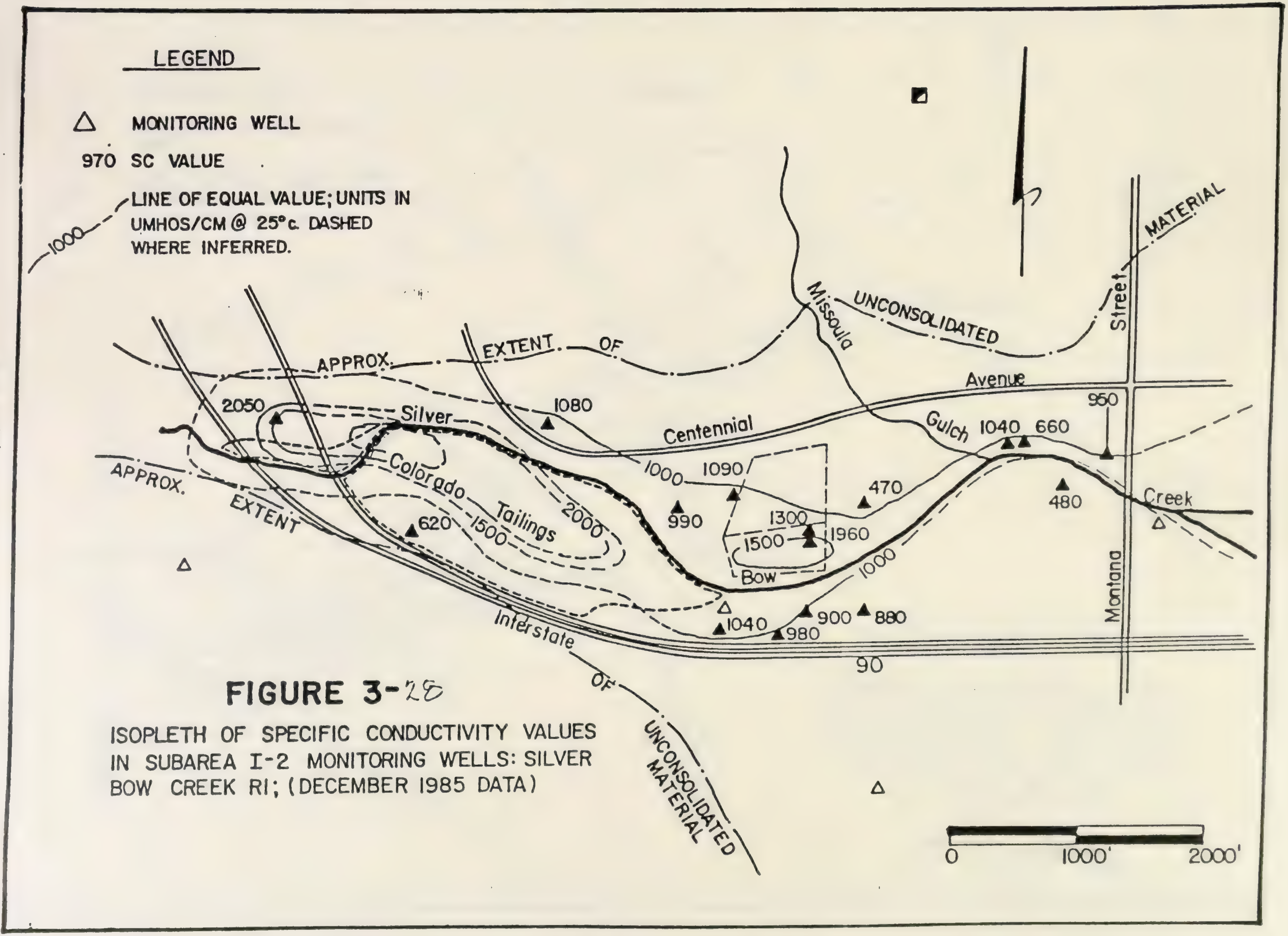


FIGURE 3-28

ISOPLETH OF SPECIFIC CONDUCTIVITY VALUES IN SUBAREA I-2 MONITORING WELLS: SILVER BOW CREEK RI; (DECEMBER 1985 DATA)

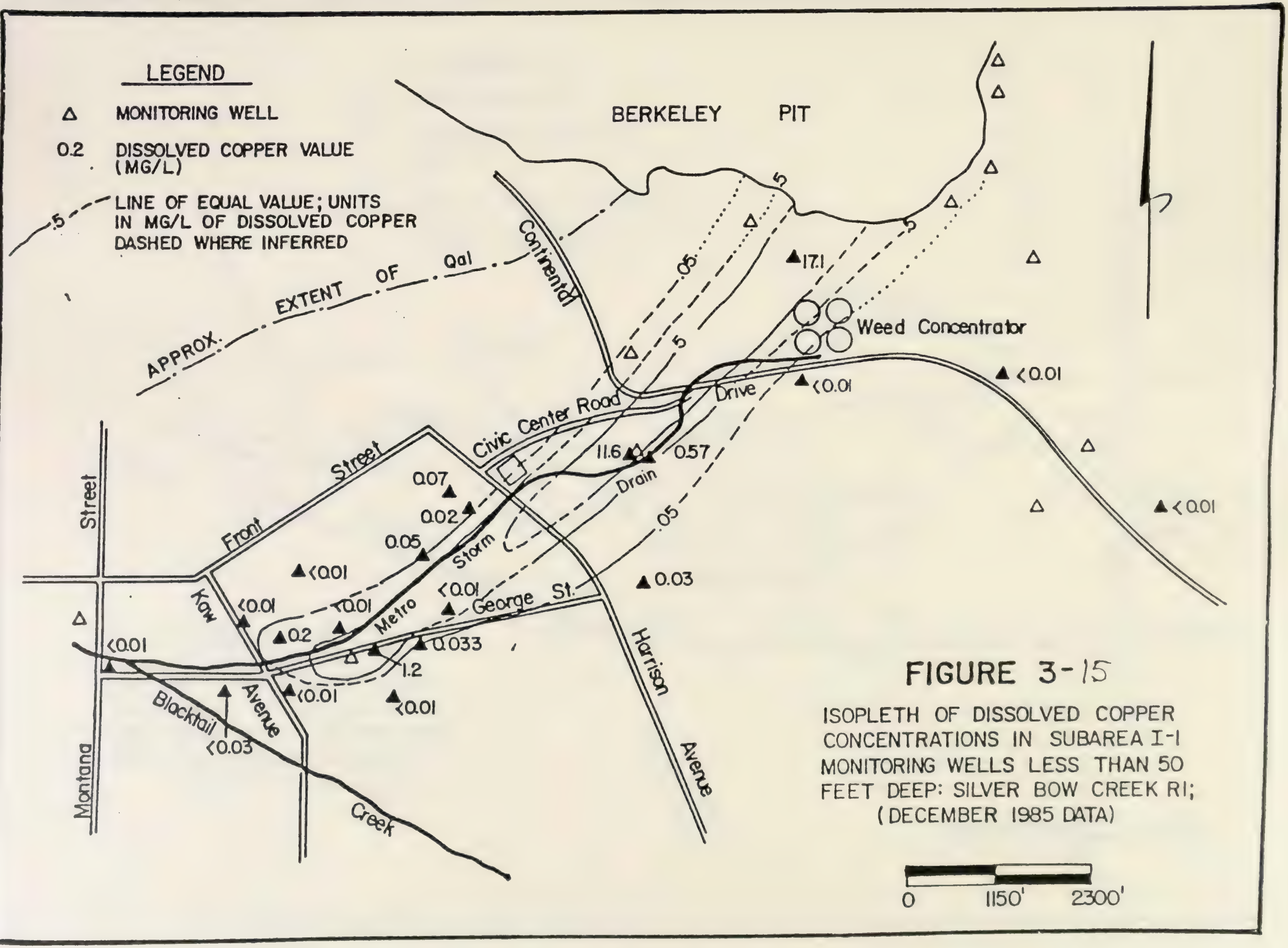


FIGURE 3-15

ISOPLETH OF DISSOLVED COPPER CONCENTRATIONS IN SUBAREA I-1 MONITORING WELLS LESS THAN 50 FEET DEEP: SILVER BOW CREEK RI; (DECEMBER 1985 DATA)

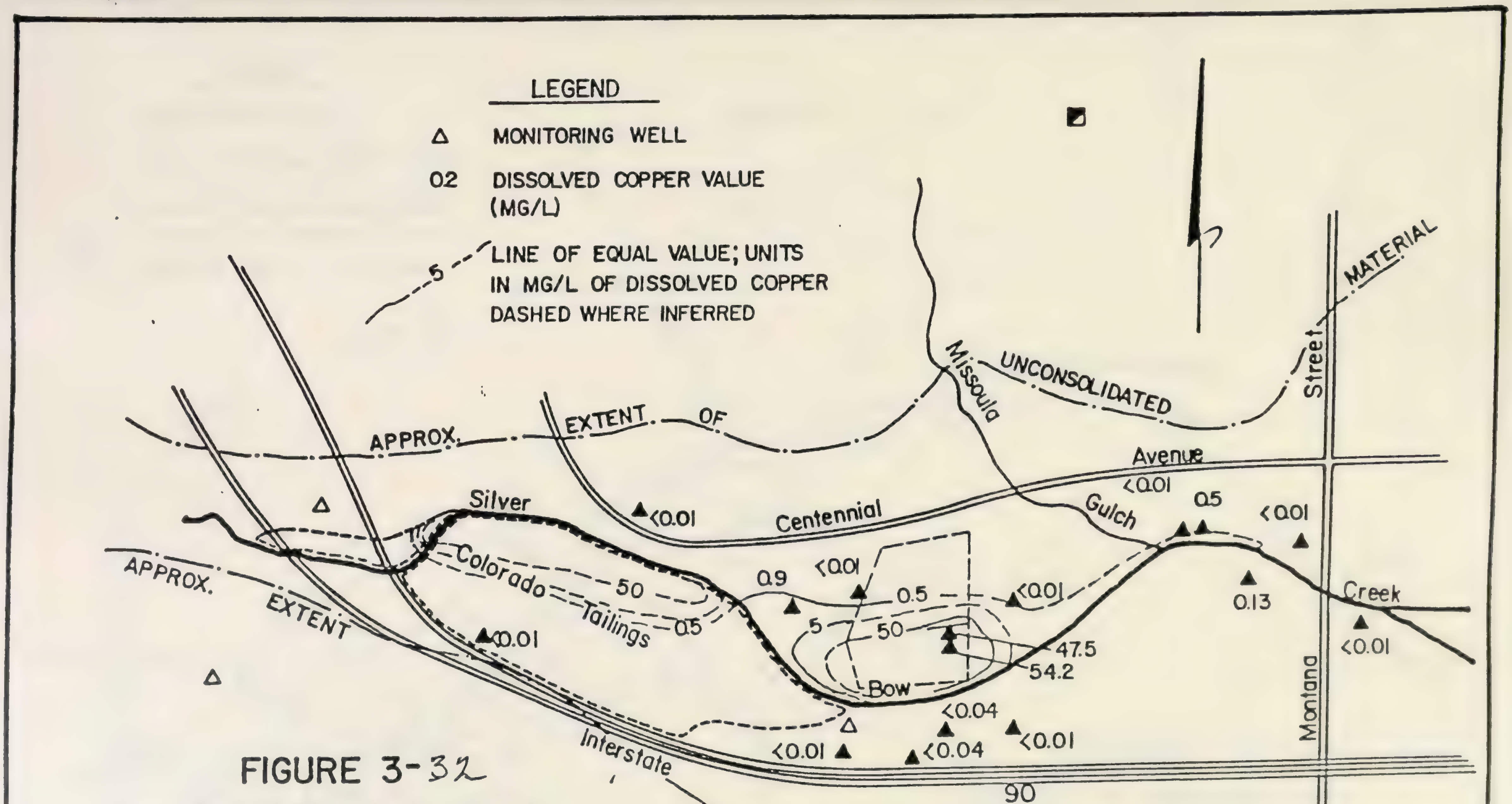


FIGURE 3-32

ISOPLETH OF DISSOLVED COPPER CONCENTRATIONS IN SUBAREA I-2 MONITORING WELLS: SILVER BOW CREEK RI; (DECEMBER 1985 AND JANUARY 1986 DATA)

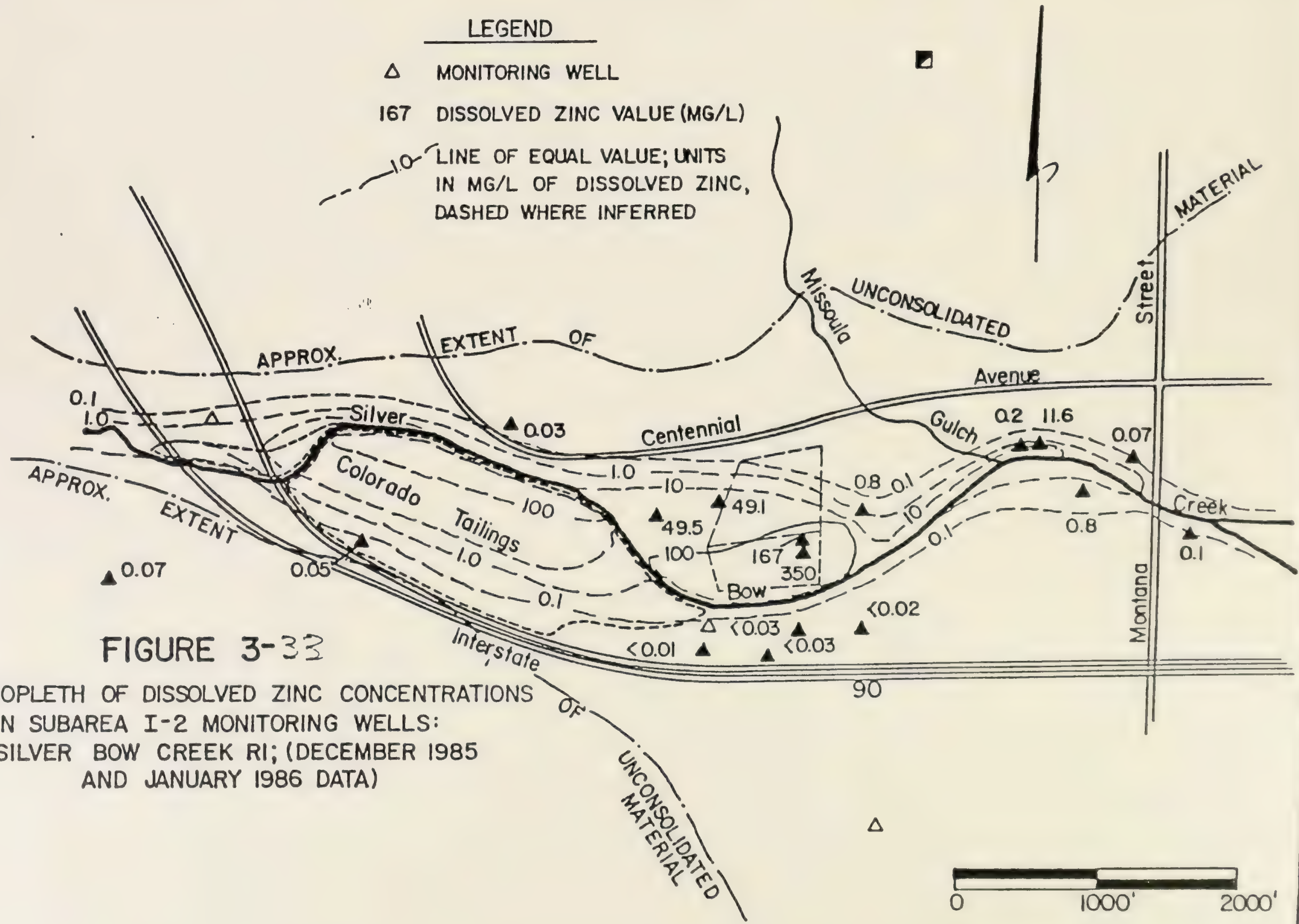


FIGURE 3-33

ISOPLETH OF DISSOLVED ZINC CONCENTRATIONS IN SUBAREA I-2 MONITORING WELLS: SILVER BOW CREEK RI; (DECEMBER 1985 AND JANUARY 1986 DATA)

ATTACHMENT B-3

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS - 01
(Data Reported on This Form)
WELL TESTED TS - 01
TEST DATE 6/2 [illegible]

Project SBC CERCLA Personnel TR. - P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 4" Well Depth(ft) 26.5' Perforated Zone(s)(ft) 16' - 26'

Desc. of MP RECORDER HOUSING BASE Stick-up(ft) +1.5' SWL below MP(ft) 9.84' SWL below GS(ft) 8.44'

Aquifer Name SBC ALLUVIUM Aquifer Description SAND, GRAVEL
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)

Distance of Observation Well from Pumping Well(ft) 0 Pump hp. & type 1HP. Pump Depth(ft) 24.0'

Water Quality Sample Taken? yes no Specific Conductance (μmhos/cm @ 25°C) ____ Temp(°C) ____ Time ____

Avg. Discharge(gpm) 28 Test Duration(min) ____ Max WL Change(ft) 187 Transmissivity (gpd/ft) ____

Storativity ____ Hydraulic Conductivity(gpd/ft²) ____ Specific Capacity(gpm/ft of drawdown) 28/9.26 = 3.02

REMARKS 50 PSI TRANSDUCER ZERO OFFSET = (-1.92); SENSITIVITY = (1.0138); IN AIR, TRANS READING = (-2.39) $Q = 2 \times (3.1259 \cdot \sqrt{h})$ h = MANOMETER

Date & hour	Time	TRANSDUCER READING	BAROMETER (In.)	MANOMETER (In.)	HEAD (ft)	DRAWDOWN (ft)	pH (S.U.)	S.C. (μmhos)	1/T
1730	00.00	10.33	30.24	15"	19.61	0			
1730.5	.5	4.65	30.23		13.16	6.45			2.86×10
1731	1.0	4.12			12.55	7.06			1.44×10
1732	2.0	3.99			12.41	7.20			7.2×10
1733	3.0	3.98			12.39	7.22			4.8×10²
1734	4.0	3.96			12.37	7.24			3.6×10²
1735	5.0	3.95			12.36	7.25			2.88×10
1736	6.0	3.96	30.24		12.36	7.25			2.4×10²
1737	7.0	3.96			12.36	7.25			2.06×10
1738	8.0	3.95			12.35	7.26			1.8×10²
1739	9.0	3.94		12.5"	12.34	7.27			1.6×10²
1740	10.0	3.76		15"	12.13	7.48			1.44×10²
1740.5	10.5	3.63		15"	11.98	7.63			1.37×10²
1741.5	11.5	4.76		16"	13.27	6.34			1.25×10²
1742	12.0	3.80			12.18	7.43			1.20×10
1743	13.0	3.82			12.20	7.41			1.11×10²
1744	14.0	3.81		16"	12.19	7.42			1.03×10²
1745	15.0	3.82	30.24		12.20	7.41			9.6×10
1746	16.0	3.81	30.25	16"	12.18	7.43			9×10
1748	18.0	3.58	30.25	16"	11.92	7.67			8×10
1750	20.0	3.08	30.26		11.33	8.28			7.2×10
1752	22.0	3.20	30.27	17"	11.46	8.15			6.5×10
1754	24.0	3.38			11.66	7.95			[illegible]
1756	26.0	3.90	30.27	17"	12.26	7.35			5.5×10

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED TS-01
(Data Reported On This Form)

WELL TESTED TS-01

Project SBC-CERCLA Personnel T.R. - P.D. TEST DATE 6-26-85

Date & hour	Time	Transducer Reading	Barometer (in)	Manometer (in)	Head (ft)	Drawdown (ft)	pH (s.u.)	Cond. (umhos)	
1805	35	3.46	30.27"		11.76	7.85			4.1x10
1806	36	3.46			11.76	7.85			4.0x10
1808	38	3.45			11.74	7.87			3.8x10
1810	40	3.44	30.29"		11.71	7.90			3.6x10
1813	43	3.45			11.72	7.89			3.3x10
1815	45	3.45	30.28"		11.7[illegible]	7.88			3.2x10
1818	48	3.44			11.72	7.89			3x10
1820	50	3.44			11.72	7.89			2.85x10
1826	56	3.43	30.29"		11.70	7.91			2.5[illegible]x10
1828	58	3.43		17"	11.70	7.91			2.45x10
1830	60	3.37	30.29"	17.5"	11.63	7.98	6.6	867	2.4x10 11°C
1840	70	3.37		20"	11.63	7.78			2.06x10
1842	72	2.59			10.74	8.87			2.00x10
1843	73	2.48			10.62	8.99			1.97x10
1844	74	2.81			10.99	8.62			1.94x10
1845	75	2.82	30.29"		11.00	8.61			1.92(
1847	77	2.83			11.02	8.59			1.87x10
1848	78	2.82	30.29"		11.00	8.61			1.85x10
1850	80	2.82	30.298"		11.00	8.61	6.6	867	1.8x10 10°C
1854	84	2.81			10.98	8.63			1.71x10
1858	88	2.81	30.30"		10.98	8.63			1.63x10
1900	90	2.83			11.00	8.61			1.6x10
1910	100	2.81	30.29"		10.99	8.62			1.44x10
1926	116	2.80	30.29"	20"	10.98	8.63			1.24x10
1934	124	2.44	30.30"	19.5"	10.56	9.05			1.16x10
1938	128	2.45		20"	10.57	9.04			1.12x10
1940	130	2.44			10.56	9.05	6.7	876	1.11x10 10°C
1950	140	2.43			10.55	9.06			1.03x10
2000	150	2.41			10.53	9.08			9.6
2010	160	2.38			10.49	9.12			9
2020	170	2.37		20"	10.48	9.13			8.5
2030	180	2.38			10.49	9.12			8
2040	190	2.37	30.31"	20"	10.47	9.14			7.6
2050	200	2.37			10.47	9.14			7.2
2100	210	2.36			10.46	9.15	6.5	801	9°C 6.9
2110	220	2.36			10.46	9.15			6.5
2120	230	2.34	30.32"		10.42	9.19			6.3

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-01
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 9-26 TO 9-27-85

Project SBC - CERCLA Personnel TA. - P.D

WELL DESCRIPTION

State MT County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 4" Well Depth(ft) 26.5' Perforated Zone(s)(ft) 16' - 26'

Desc. of MP RECORDER HOUSING BASE Stick-up(ft) +1.3' SWL below MP(ft) 9.74' SWL below GS(ft) 8.44'

Aquifer Name SBC - ALLUVIUM Aquifer Description SAND, GRAVEL
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify)

Distance of Observation Well from Pumping Well(ft) ____ Pump hp. & type 1 H.P. Pump Depth(ft) 24.0'

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ____ Temp(°C) ____ Time ____

Avg. Discharge(gpm) 28 Test Duration(min) 1440 Max WL Change(ft) 187 Transmissivity (gpd/ft) ____

Storativity ____ Hydraulic Conductivity(gpd/ft²) ____ Specific Capacity(gpm/ft of drawdown) ____

REMARKS ____

Date & hour	Time	TRANSDUCER READING	BAROMETER (in)	MANOMETER (in)	HEAD (ft)	DRAWDOWN (ft)	pH	S.C. (µmhos)	
2130	240	2.34	30.32		10.42	9.19			6
2215	285	2.45	30.34		10.53	9.10	6.4	823	7.5
2230	300	2.44	30.36		10.49	9.12			4.8
2240	310	2.45	30.35	20"	10.51	9.10			4.6
2250	320	2.43			10.49	9.12			4.5
2300	330	2.42			10.48	9.13			4.4
2310	340	2.39	30.34		10.46	9.15			4.2
2320	350	2.41			10.48	9.13			4.1
9-27-85 0020	410	2.39			10.46	9.15			3.5
0045	435	2.38	30.35		10.43	9.18			3.3
0100	450	2.39	30.36	20"	10.43	9.18			3.2
0200	510	2.41	30.35	20"	10.47	9.14			2.8
0300	570	2.38	30.34	20"	10.45	9.16			2.5
0400	630	2.39	30.31		10.49	9.12			2.3
0500	690	2.38	30.28		10.51	9.10			2.1
0600	750	2.37			10.50	9.11			1.92
0700	810	2.21	30.24		10.25	9.36			1.8
0800	870	2.17	30.36		10.18	9.43	6.7	753	1.7 10°
0900	930	2.20	30.33		10.25	9.36			1.5
1000	990	2.21	30.31		10.29	9.32	6.7	847	1.5 8.5°
1100	1050	2.20	30.30		10.29	9.32			1.4
1200	1110	2.18	30.30		10.26	9.35	6.8	824	1.3 9.5
1400	1230	2.20	30.25		10.34	9.27	6.9	838	1.2 11°
1540	1330	2.20	30.20		10.40	9.21			1.1

AQUIFER TEST DATA
(Cont.)

WELL OBSERVED TS-01
(Data Reported On This Form)

WELL TESTED TS-01

Project SBC-CERCLA Personnel TR.-P.D. TEST DATE 6-27-85

Date & hour	Time	TRANSDUCER READING	BAROMETER (In)	MANOMETER (In)	HEAD (Ft)	DRAWDOWN (Ft)	pH (SU)	SC (umhos)
1721	1431	2.16	30.20	20"	10.35	9.26	6.4	533
1730	1440	2.16	30.20		10.35	9.26		

AQUIFER TEST DATA

STILLER AND ASSOCIATES
CONSULTING HYDROLOGISTS · GEOLOGISTS · ENGINEERS

WELL OBSERVED TS-01
(Data Reported on This Form)
WELL TESTED TS-01
TEST DATE 6-27-84

Project SBC - CERCLA Personnel T.R. - P.D.

WELL DESCRIPTION

State MONTANA County SILVER BOW Location: T 3N R 9W Sec. 22 Tract AAD

Borehole Diam.(in) 6 5/8" Well Diam.(in) 4" Well Depth(ft) 26.5' Perforated Zone(s)(ft) 16-26'

Desc. of MP BASE OF RECORDER HOUSING Stick-up(ft) +1.5' SWL below MP(ft) 9.84' SWL below GS(ft) 8.44'

Aquifer Name ______ Aquifer Description ______
(Lithology, Thickness, Depth to Top)

TEST DESCRIPTION

Test Type: (Circle One)
1. Pumping Well Drawdown
2. Observation Well Drawdown
3. Pumping Well Recovery
4. Observation Well Recovery
5. Bailer Recovery
6. Slug Injection or Removal
7. Hvorslev Test
8. Other (Specify) ______

Distance of Observation Well from Pumping Well(ft) ______ Pump hp. & type 1 HP Pump Depth(ft) ______

Water Quality Sample Taken? yes no Specific Conductance (µmhos/cm @ 25°C) ______ Temp(°C) ______ Time ______

Avg. Discharge(gpm) ______ Test Duration(min) 187 Max WL Change(ft) 9.43 Transmissivity (gpd/ft) ______

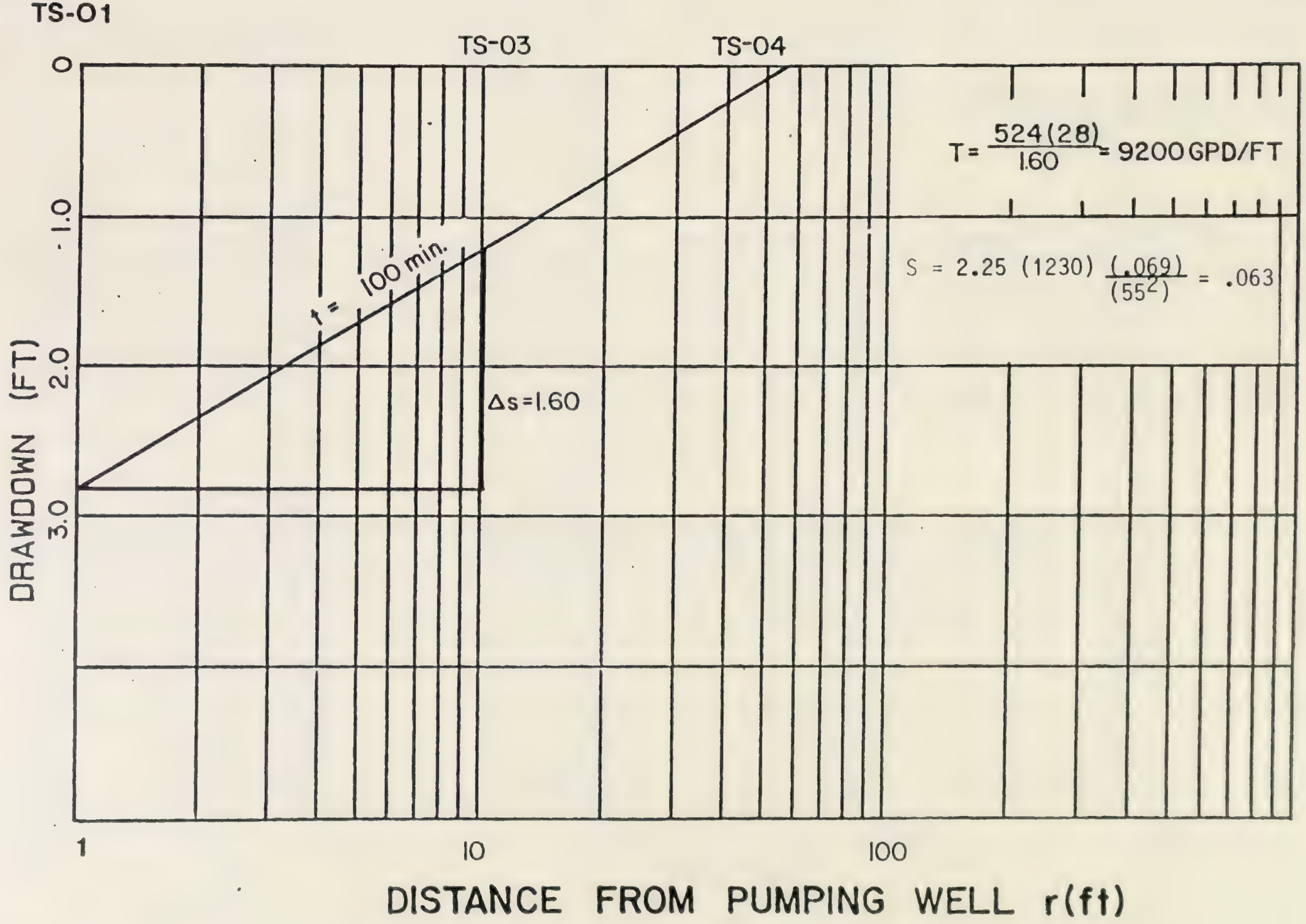
Storativity ______ Hydraulic Conductivity(gpd/ft²) ______ Specific Capacity(gpm/ft of drawdown) ______

REMARKS TRANSDUCER 50 PSI SENSITIVITY = 1.0138 ZERO OFFSET = (-1.92) AIR INST. READING = (-2.39)

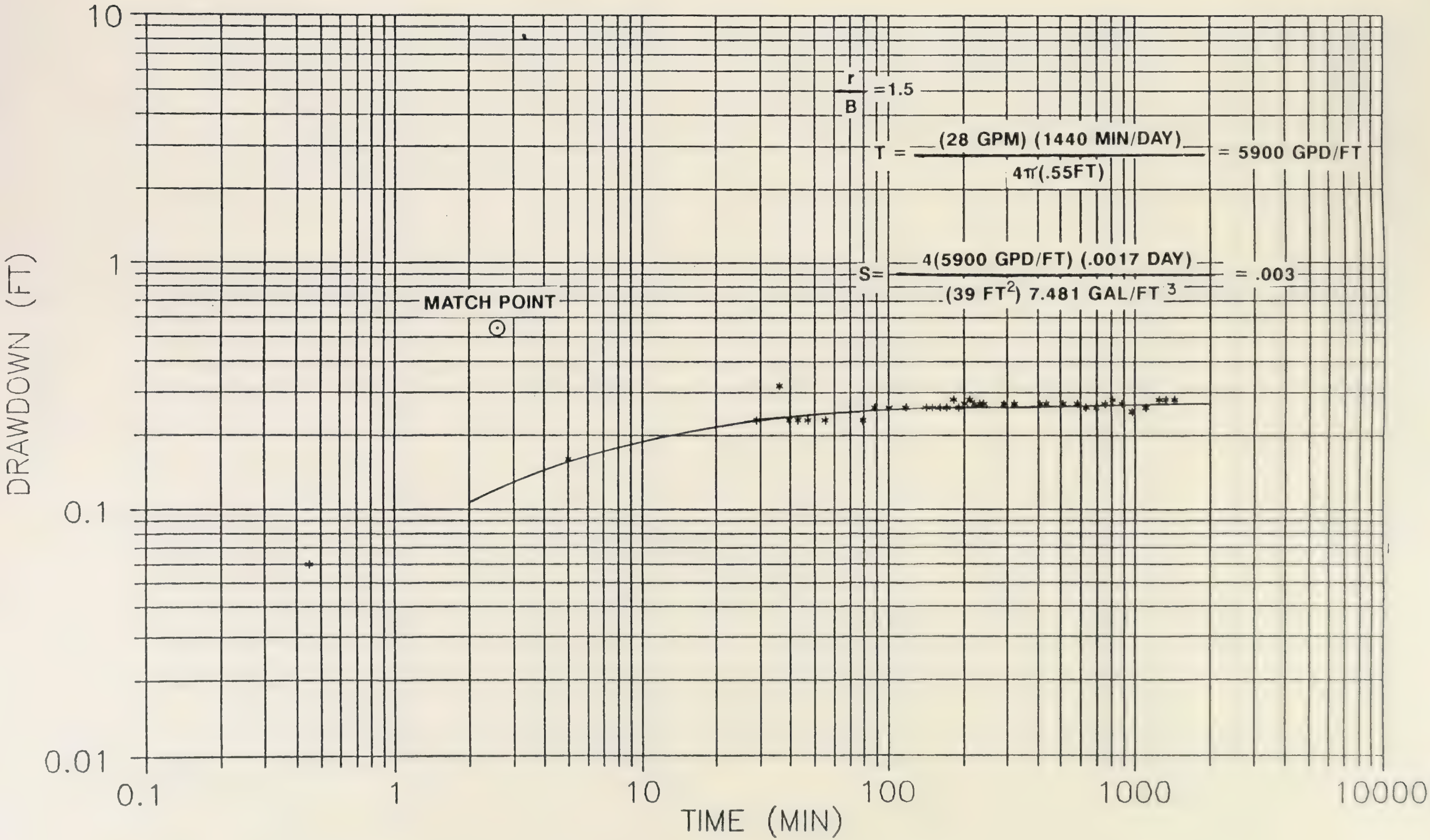
Date & hour 6-27-85	Time t	t'	t/t'	TRANSDUCER READING	BAROMETER READING	HEAD (In)	RESIDUAL DRAWDOWN	
1730	1440	00.0	0	2.16	30.21	10.34	9.27	
1730.5	1440.5	0.5	2881	9.31		18.49	1.12	
1731	1441	1.0	1441	10.00		19.27	0.34	
1732	1442	2.0	721	10.16		19.46	0.15	
1733	1443	3.0	481	10.20	30.21	19.50	0.11	
1734	1444	4.0	361	10.22	30.23	19.50	0.11	
1736	1446	6.0	241	10.23		19.51	0.10	
1738	1448	8.0	181	10.24		19.53	0.08	
1740	1450	10.0	145	10.24		19.53	0.08	
1746	1456	16.0	91	10.24	30.23	19.53	0.08	
1750	1460	20.0	73	10.24		19.53	0.08	
1755	1465	25.0	58.6	10.24		19.53	0.08	
1800	1470	30.0	49	10.24		19.53	0.07	
1805	1475	35	42	10.25		19.54	0.07	
1810	1480	40	37	10.24		19.53	0.08	
1940	1576	136	12	10.27		19.56	0.05	
2037	1627	187	9	10.28	30.24	19.56	0.05	

ATTACHMENT B-4

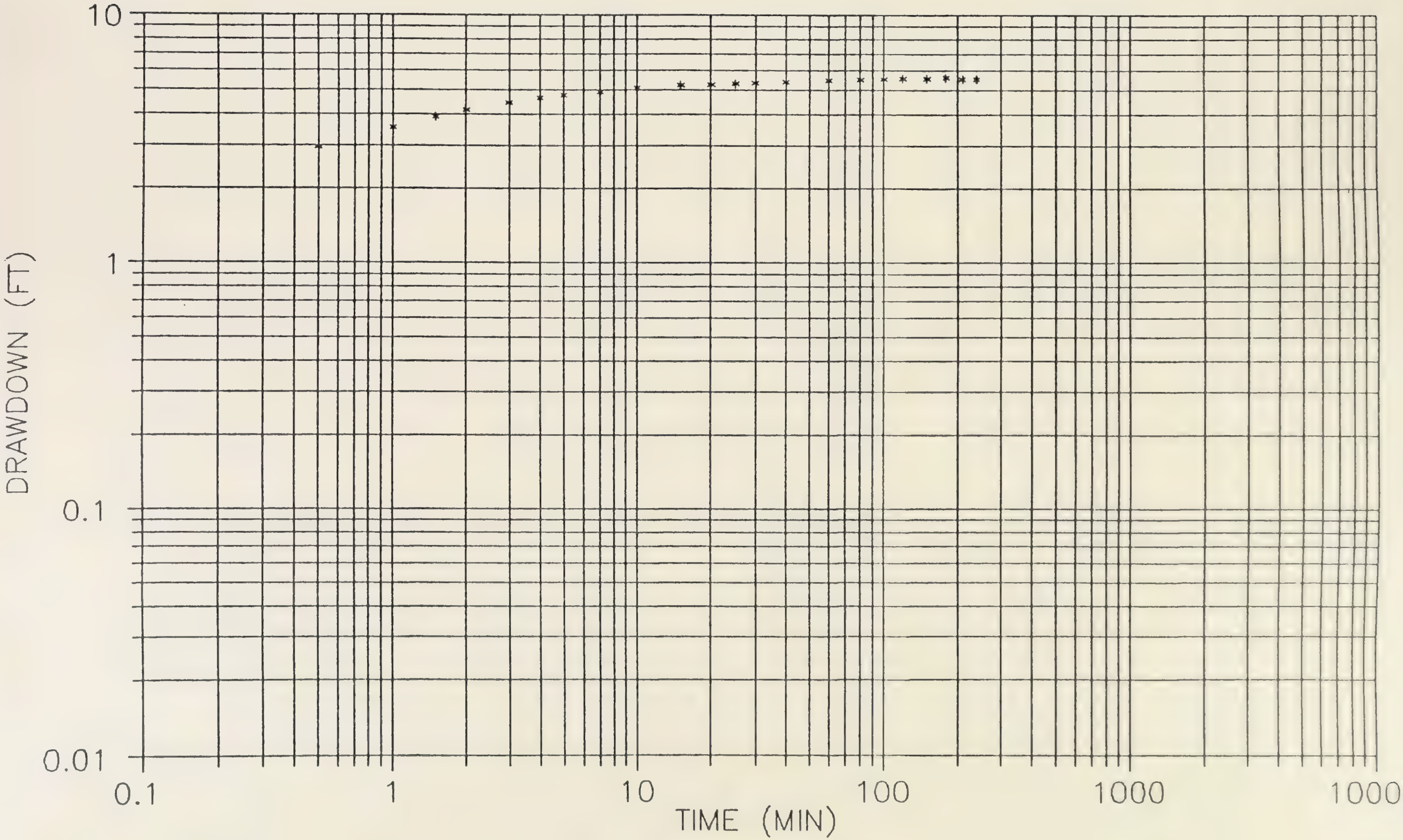
JACOB DRAWDOWN TEST OF
OBSERVATION WELLS TS-03 AND TS-04



OBSERVATION WELL TS-04

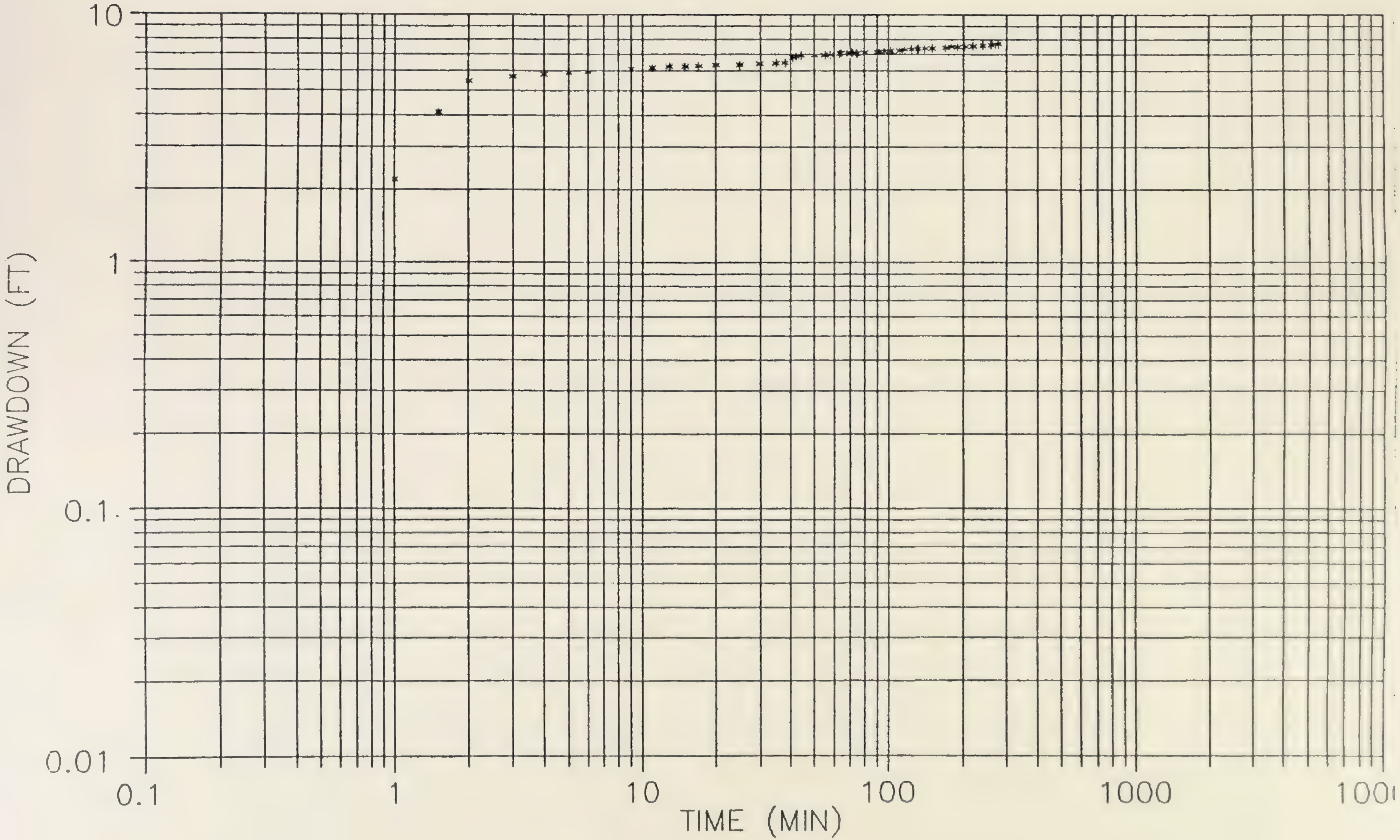


PUMPING WELL GS-03



ATTACHMENT B-5

PUMPING WELL GS-01



WARM SPRINGS POND INVESTIGATION
(APPENDIX C, PARTS 1 AND 2)

OVERVIEW

The Warm Springs Ponds Investigation (MultiTech 1987b) of the Silver Bow Creek RI was designed and implemented to collect new data that could be used in conjunction with existing data for two purposes: 1) to describe the extent and severity of surface water and groundwater contamination in Silver Bow Creek and Upper Clark Fork River, and 2) to assist in the evaluation, selection, and design of remedial alternatives. The most significant finding relative to groundwater is the presence of a contaminant plume north and west of Warm Springs Ponds.

GENERAL COMMENTS

The draft report for the Silver Bow Creek RI contains factual data that are relevant to determining the extent of groundwater contamination in the vicinity of the Warm Springs Ponds and the Opportunity Ponds. The report documents the degradation of groundwater from both mining and milling operations and natural sources (e.g., fluoride contamination). However, this report contains statements that are made without referenced data or calculations.

The presence of hot springs in the vicinity of the Warm Springs Ponds is not mentioned in the report except for a brief reference on page 3-60. The hot springs are a potential source of contaminants (e.g., fluoride) and a reason for poor water quality. Prior to mining and milling, groundwater quality for some constituents was probably poor. Mining and milling may have contributed to the overall degradation of groundwater quality, but these operations are not the only sources of that degradation.

The report on the Warm Springs Ponds Investigation relies too much on subjective adjectives to state conclusions. For example, the word "significant" is used on numerous occasions with no statistical or quantifiable definition of what the word means in each situation. Examples of this use of subjective adjectives are found on pages 3-28, 3-35, 3-65, and 4-10. Other examples are provided in the following section entitled "Specific Comments".

The presentation of hydrologic and geochemical baseline conditions is very weak. This comment applies to both historical conditions and those upgradient of contaminated areas.

Inferences and generalizations are presented throughout the RI report. These unsubstantiated statements should be stricken from the RI report or information should be provided to verify statements. Some data presented in the attachments are in computer string format without proper annotations concerning parameters. Data presented in this manner are not usable in verifying statements and calculations in the RI report. Often, generalizations are stated such that the reader could infer that statistical analyses were performed. However, no statistical results are provided. Historical data are used sparingly. Minimal reference is made to Anaconda Minerals Company studies. For example, no data from wells in the vicinity of the eastern Opportunity Ponds are used. Poor quality surface water and groundwater are often inferred from specific conductance measurements.

> Response: Comments presented in this section are addressed in association with responses to specific comments in the following section.

SPECIFIC COMMENTS

The following items are specific, page-by-page comments to the subject report:

1. Page 2-11, Table 2-4: The list of seepage run parameters is not consistent with parameters (e.g., lead) that are the focus for the Groundwater and Tailings Investigation. This inconsistency should be explained.

   Response: Metals sampled during surface water investigations are the same as those collected during groundwater sampling (see Table 2-1, page 2-4). For the seepage run, however, only copper and zinc were of concern because these were the only metals that regularly exceeded aquatic criteria in the Mill-Willow Bypass (see Table 4-2, page 4-2). In 14 samples collected at the various surface water stations during high flow on April 10, 1985, lead exceeded the acute criterion for one sample. This criterion was not exceeded during low flow sampling for the seepage runs.

2. Page 2-15, Line 18: Where are samples archived? That location should be mentioned in the text.

   Response: Selected samples collected during drilling activities are archived at CHEN-NORTHERN's soils laboratory in Helena.

3. Page 2-16, Third Paragraph and Figure 2-3: The well completion description and accompanying figure indicate a potential pathway of contamination to the monitored interval in each well. Contamination could move from the backfill into the water table and then into the monitored interval. This contamination will result in inaccurate water quality samples. Backfilling with pea gravel increases the chances of moving contaminated material from near the land surface to near the monitored interval. Well logs indicate that "pea gravel" was used for backfill at Wells WSP-1, WSP-2A and B, WSP-4, and WSP-5. The text indicates "pea gravel and bentonite mixture". Which one is correct? Assurance that proper well sealing methods were used must be provided. This assurance may be provided by examining or sampling the annulus seal below the bentonite seal to determine its composition. Assuming that only pea gravel was used as backfill and

that the monitored interval contains water of better quality than that contained in the backfill, contaminants in the backfill could move around the bentonite seal and into the monitored interval, thus giving an inaccurate picture of the water chemistry. A preferred completion technique is to fill the annulus with bentonite grout, cement grout, or a mixture of the two as described in Driscoll (1986) and U.S. EPA (1985a).

Response: Monitoring well installation techniques utilized during the Phase I RI were in accordance with those presented in the project work plan (MultiTech, 1984a) and represented the standard of practice as of that date. Continued refinement in monitoring well construction technology has possibly resulted in more advanced installation designs to minimize cross contamination in a properly constructed monitoring well. It is unlikely collected groundwater data are invalid because of construction designs. However, in certain circumstances, it may be appropriate to construct and sample a limited number of monitoring wells adjacent to selected Phase I wells in accordance of today's standards such that analyses of the data can be refined. AMC certainly may, under State order and appropriate supervision, pay for and install confirmatory wells.

The pathway described wherein contaminants could move from a zone occupied by the pea gravel backfill, around the bentonite plug, and into the monitored interval is unlikely for the following reasons:

- o Bentonite seals were installed in lithologies which were judged to represent an aquitard within each borehole.

- o Measured horizontal to vertical hydraulic conductivity ratios in the Warm Springs Ponds area during the Phase II RI were on the order of 30:1. These data support the contention that the majority of water moving through the well screen during sampling events is derived from areas adjacent to the screen, not from overlying groundwater systems.

- Analyses of samples collected from confirmation wells installed during the Phase II RI in the Warm Springs Ponds area, and in accordance with procedures AMC describes, were similar to analyses for synchronous samples collected from Phase I RI monitoring wells.

4. Page 2-24, Line 7: The text indicates that graphs were prepared to show the loads of various contaminants at all stations on the Mill-Willow Bypass, yet none was presented. These graphs should be presented.

   Response: Loading graphs for Mill-Willow Bypass sampling sites are not included in the Phase I RI report. However, Table 3-19 in the Phase I report summarizes load increases during low flow sampling periods in the bypass.

5. Page 2-27, Line 5: How does the concentration of iron affect behavior of other metals? This statement needs further explanation or a reference.

   Response: Quoting from the Study and Interpretation of the Chemical Characteristics of Natural waters (J. D. Hem, 1985, 3rd Edition, United States Government Printing Office, p. 78), "Ferric oxyhydroxide surfaces have a substantial adsorption capacity which may affect the concentration of minor constituents of water associated with such (organic colloidal or humic-type) material. Redox coprecipitation processes may occur that can control solubilities of other metal ions under some conditions."

6. Page 2-35, bulleted items: The list of sampled constituents is not consistent with parameters (e.g., lead) that are the focus of other parts of the RI (e.g., the Groundwater and Tailings Investigation). This inconsistency should be explained.

Response: The Groundwater and Tailings Investigation analysis also emphasizes zinc and copper. These are the metals that exceed aquatic criteria most frequently in the ponds (see Table 4-2 on page 4-3). With the exception of the inflow, the total lead levels were near the detection limit during the mass balance study period, decreasing the usefulness of a detailed mass balance for this parameter. Inspection of the data shows that total lead was definitely deposited in the ponds during investigations associated with the Phase I Remedial Investigation.

7. Page 2-35, Line 19: There is no key provided for Attachment VII. Because the data are listed in computer string format, a key should be provided to determine appropriate values and to allow interpretation by the reader.

   Response: As noted at the top of page VII-1, the format for the input is the same as that for the output which begins on page VII-14. Specifically, the parameters are:

   Station identification
   Date
   Discharge
   Specific Conductance
   Sulfate
   Total iron
   Dissolved iron
   Total zinc
   Dissolved zinc
   Total copper
   Dissolved copper
   Total phosphorus
   Ortho phosphate

8. Page 2-37, Line 19: Why are data for the Opportunity Pond discharges interpolated for missing periods? This interpolation may lead to erroneous conclusions concerning trends.

Response: The Opportunity Pond discharges were observed to remain fairly constant, as were most constituent concentrations throughout the study period. This allowed for less frequent sampling and flow measurements. Metals concentrations are less than 1% of the mass load, and therefore do not affect the mass balance calculation.

9. Page 2-40, Line 5: Data concerning the planimeter measurements should be presented. The area should be presented on a map.

   Response: The area contributing runoff to the ponds is a readily identifiable and quantifiable item. Although the area that drains to the Berkeley Pit, which is part of this drainage, is not so easily identified or quantified, it is allowed for as described on page 3-38.

10. Page 2-43, Line 2: Given that pH is quite variable in the pond water, and that the pH range in the text is large for equilibrium calculations, what confidence can be placed on these calculations and Figures 2-7, 2-8, and 2-9? Because hydrogen ion concentration (expressed as pH) is an important factor in stability relationships and these relationships control transport and fate of metal contaminants, high confidence in these values is needed.

    Response: The range in the pH within the pond system is quite large during the year, but at any given time the pHs measured within the system are generally close. Therefore, equilibrium calculations at a point in time can be made with some confidence, but those calculations are only valid for that time.

11. Page 3-4, Line 13: It would be more meaningful if a standard deviation and range were provided for each constituent. Averages eliminate the ability to interpret.

Response: The referenced discussion is a review of the historic data which cannot be used for RI interpretation. However, these data can be used to guide the RI study. They were used for this purpose.

12. Page 3-4, Line 15: Are drinking water standards the proper criteria by which to evaluate water quality of Silver Bow Creek? The river is classified as industrial in this section. In addition, these criteria are based on individual samples, not mean concentrations as implied in the statements of Lines 15-19.

Response: The appropriate standards for evaluation of Silver Bow Creek water quality were only preliminarily identified at the time of the Phase I RI study. They are still being finalized. Both drinking water standards and aquatic criteria are applicable, relevant or appropriate requirements. The statements concerning percent exceedances are based on individual samples, not averages.

13. Page 3-21, Line 2: Table 3-10 provides average efficiencies for the total mass balance study period. However, no confidence interval or standard deviation is provided to evaluate the statistical significance of the data. A confidence interval or standard deviation is needed to evaluate the statements made.

Response: The numbers in Table 3-10 are individual calculated values, not averages of the semi-monthly periods. Averaging the semimonthly values would not be particularly significant because the individual values represent clearly different hydrologic conditions.

Because the numbers in Table 3-10 are unique pieces of data, they provide a "snap shot" of hydrologic conditions at the time samples were taken. While the data can be evaluated to provide a general range of efficiencies expected under similar operational conditions, such an evaluation was not deemed to be useful at this screening level stage in the RI.

If AMC is concerned about the confidence interval for the average efficiency values, it may wish to perform and pay for, subject to State order and appropriate State oversight, either a mass-balance analysis over several summer seasons, or a sensitivity analysis by assuming ranges of error for the various inputs for the existing data. Either of these methods would be suitable to determine the reliability of the figures provided in Table 3-10.

14. Page 3-21, Line 8: Sulfate is said to "apparently act nonconservatively at some times of the year". No information or data are presented to substantiate this comment. It is stated that the ponds are a "source" of sulfate, but no data are presented.

    Response: The enclosed tables (Attachment C-1) present the efficiency data by calculation interval. These data indicate that sulfate load increases in the pond system during some of the time intervals.

15. Page 3-24, Line 10: The data for dissolved metals should not be considered incomplete because measured concentrations in the inflows and outflows were less than the analytical detection limits. The data exist but are below detection limits. This implies that the ponds are efficient in removing metals.

    Response: The data are not incomplete, but Table 3-10 is incomplete because both inflow and outflow concentrations from Pond 2 are below detection for some periods. This prevents the calculation of an efficiency for the overall period. If the inflow and outflow concentrations are both below the detection limit, no statement on the efficiency of the ponds is possible.

16. Page 3-25, Line 7: A reference for the calculations of evapotranspiration from the 525 ac of willows and nearshore grasses should be provided. The correlation between the transpiration of alfalfa and willows and nearshore grasses needs to be explained.

Response: Data on the evapotranspiration of wild vegetation are not available. It was assumed that willows have a very high consumptive use, similar to that of a highly consumptive cultivated crop such as alfalfa. In the absence of data for evapotranspiration of wild vegetation, the use of alfalfa evapotranspiration rates was a conservative assumption. If AMC believes that specific evapotranspiration data for willows and near-shore grasses should be obtained, AMC should submit a work plan to the State for AMC's performance, subject to State oversight, of a pilot study to obtain such data.

17. Page 3-27, Line 6: What is meant by "...the change in storage volume term...averaged out over the course of the study"?

Response: The inflow-outflow study was only used to corroborate the mass-balance calculations and, therefore, even if specific measurements of the change in storage volume were obtained, such measurements would not modify the Phase I RI's conclusions.

18. Page 3-27, Line 15: Some indication of the confidence intervals for the pond efficiency calculations should be presented in Table 3-12.

Response: Confidence intervals for the mass balance calculations can be calculated, but because of the large number of inputs to the system and the number of parameters that were evaluated it would require a considerable amount of time and effort. The hydrologic system is a dynamic system and, therefore, "true values" can only be obtained for an instant in time. The use of confidence intervals really suggests an irrelevant exercise. Calculations of a range of values may, however, be useful. If it is determined that such ranges are necessary during the feasibility study for the Warm Springs Ponds, they will be calculated.

19. Page 3-27, Line 17: No indication of the confidence intervals has been provided for either the inflow/outflow or the mass balance studies. Any conclusions regarding the efficiencies assume 100-percent accuracy in the assumptions inherent in the calculations. Less accurate values will result in less accurate conclusions. Loadings are directly proportional to flow rate and will reflect any inaccuracies in flow rates. Removal efficiencies are based upon loadings and are a part of the mass balance studies. Thus, reduced confidence in removal efficiencies will affect mass balance studies.

Response: The confidence that can be placed in individual load calculations was explained in Chapter 2.0 of the Phase I RI document (Appendix C). This type of analysis of confidence intervals is directly applicable to the mass balance calculations.

20. Page 3-28, Line 2: The statement "Pond 2 is significantly less efficient in removing all contaminants except cadmium" is unsubstantiated. Significance should be defined statistically or in a manner that allows for quantification (e.g., $\leq$ 10 percent).

Response: See the response to comment 18 in this document.

21. Page 3-29, Line 1: No statistical confidence intervals have been provided for the calculated values in Table 3-13. These confidence intervals are needed to evaluate statements based upon Table 3-13.

Response: See the response to comment 18 in this document.

22. Page 3-29, Line 2: What is meant by the phrase "this error averages out"?

Response: The error refers to the neglect of the "change in storage" term in the calculation of mass balance. The unknown change

in storage is most likely small compared with the total discharge through the ponds over the RI period. If this is true, concentrations and loads are equal to the concentration times the volume where the volume is virtually constant. A comparison of decreases in load and concentration (Table 3-13) confirms the closeness of these calculations, in spite of water balance inaccuracies.

23. Page 3-29, Line 7: No statistical confidence intervals have been provided for the calculated values of Tables 3-14 and 3-15. These confidence intervals are needed to evaluate statements based upon Tables 3-14 and 3-15.

    Response: See the responses to comments 13 and 18 in this document.

24. Page 3-30, Line 6: Several factors are recommended for consideration during remedial design for Warm Springs Ponds. The rationale for considering those factors should be presented or referenced.

    Response: The rationale are presented. The point was made that the wildlife ponds performance greatly exceeds that of Pond 2 and the differences in treatment are outlined. Inflow rate, depth, and bottom sediment composition are obvious factors in any treatment system.

25. Page 3-31, Line 9: The statement indicates the ponds behave similarly. Does this mean in metals removal, seasonal variation, or high/low flow rates? The intent of the statement is unclear and needs to be clarified.

    Response: Both ponds respond similarly for metals removal, given that the inflow concentrations vary. The intent of this statement is to indicate that the mechanisms discussed theoretically in this section apply to both ponds.

26. Page 3-31, Line 16: The statement that sulfate "tends to behave inversely with flow rate" is unsubstantiated. No statistical analysis of sulfate concentration vs. flow rate at the pond outlet was presented. These averages, as presented in Table 3-16, Page 3-33, cannot be used with confidence to make these conclusions.

Response: The winter and spring sulfate data of Table 3-16 are significantly different at the 95% confidence level, as are the summer and spring data. A regression analysis could be used to determine the mathematical relationship between sulfate concentrations and flow. However, this information is superflous; the qualitative analysis is valid and was sufficient for purposes of the RI. Moreover, sulfate is not considered a contaminant of concern at this site.

27. Page 3-32, Line 6: Values of pH 7.5 are not "very low pH".

Response: The point is that copper precipitates at this pH but zinc and cadmium remain primarily in solution.

28. Page 3-32, Line 10: A cursory review of the RI algae data would be relevant to the discussion of metal stabilities in the pond system.

Response: Discussion pertinent to this topic is contained in Appendix D of the Phase I RI report.

29. Page 3-32, Line 17: No reference is provided for the discussion of arsenic speciation.

Response: The reference is cited in the text (Misra and Tiwar, 1963).

30. Page 3-34, Line 9: No reference is provided for the reported algae blooms.

Response: The Montana Department of Health and Environmental Sciences has observed high algal growth in the ponds, although it has not published any observations previous to those contained in Appendix D.

31. Page 3-35, Line 3: Averaged sediment data for Warm Springs Pond are presented in dry-weight concentrations. Attachment VIII presents data in wet-weight concentrations. Because laboratory water content data are not provided, the data presented in Table 3-17 cannot be verified.

Response: The percent solids data in Attachment VIII allows the conversion of wet-weight data to dry-weight.

32. Page 3-35, Line 6: The pond system is designed to trap sediments as they travel toward the Clark Fork River. Metalliferous sediments should therefore be expected in the pond bottom sediments. Justification for why the values are extreme should be provided.

Response: The commentator's editorial comment with respect to the use of the word "extreme" is duly noted. The author intended by usage of the word "extreme" to indicate that metal concentrations found in the pond bottom sediments are very high compared to the metal concentrations in river sediments adjacent to the site. The metal concentrations in pond bottom sediments are also very high compared to background values.

33. Page 3-35, Line 14: "Extreme concentrations" should be quantified.

Response: See response to comment 32 in this document.

34. Page 3-36, Line 6: The total organic carbon (TOC) content is stated to vary "widely;" however, "Pond 2 contains a generally higher TOC content." Without supporting statistical data, the statement must be considered speculative.

Response: A re-evaluation of TOC data indicated that there is no statistical difference in TOC values. This correction to what was a draft Phase I RI report is duly noted. The re-evaluation does not, however, affect the pertinent conclusions in this portion of the RI.

35. Page 3-41, Line 19: Inferences are made concerning the trend of specific conductance with distance downstream in the Mill-Willow Bypass. Data contained in Attachment IX are not noted as being compensated for temperature. If the data are uncorrected for temperature, any discussion of trends may be incorrect. In addition, these data should be shown graphically with relevant statistical analyses. For example, an uncompensated temperature difference of 5^{0} C results in a 9 percent difference between the measured conductivity and the conductivity at 25^{0} C, the standard temperature for reporting specific conductance measurements.

    Response: The specific conductance data presented in the RI are corrected for temperature.

36. Page 3-45, Line 3: Why are the specific conductivity data from monitoring Wells DW-340 and DW-401 for 1979 anomalous? There are numerous wells in this region. Why were these data omitted?

    Response: 1979 specific conductivity data for wells DW-340 and DW-401 were considered anomalous because data from this year represent an abnormality in the general upward trend of specific conductivity values for the period 1977-1985. Data from other wells in the Opportunity Ponds area were omitted because the intent of the report was to focus on the Warm Springs Ponds area; characterization of the Opportunity Ponds area is being completed in a separate investigation. Limited data for the Opportunity Ponds area are presented in an attempt to tie the two sites together.

37. Page 3-45, Line 10: No correlations for metals are presented. These correlations are needed to understand the system. How are total metals concentrations correlations "inconsistent"? No hypothesis for metals concentrations was presented. Why are the historic Anaconda Minerals Company metals data be judged suspect? Justification for this conclusion needs to be presented.

<u>Response</u>: It was not the intention of the Phase 1 RI to characterize the groundwater system in the Opportunity Ponds area. The Phase 1 RI was a screening study, and such characterization was beyond the scope of the study. The characterization of groundwater in the Opportunity Pond area is being completed through a separate study.

Anaconda Minerals Company metals data for monitoring wells were judged suspect because of widely variable concentrations of various metals between sampling periods. Given the short time periods between sampling periods (e.g. 3 months), it is not reasonable that such wide fluctuations (greater than an order-of-magnitude) would occur in a low to moderate permeability groundwater system. The metals which exhibited these wide fluctuations were also not consistent between sampling periods, lending further doubt to temporal analysis of these data.

38. Page 3-48, Line 2: No statistical analysis relating correlation of iron-stained sand units and elevated dissolved iron concentration was presented. Therefore, the statement is only hypothetical.

<u>Response</u>: The intent of the statement was not oriented toward statistical correlations but rather to offer the observation that samples collected from monitoring wells completed in iron-stained sand units (as identified during field logging of drill cuttings) correlated with elevated dissolved iron concentrations in groundwater samples collected from the same lithology. These types of visual field observations of obvious physical conditions are qualitative and need not be supported by statistical analysis.

39. Page 3-48, third paragraph: A water table map would be helpful in visualizing the water table surface. Presently, the characteristics of the groundwater flow system cannot be examined easily and readily.

<u>Response</u>: A water table map of the shallow groundwater system in the Warm Springs Ponds area is included as Attachment C-2 to this document. The map indicates groundwater movement is generally to the north in the Warm Springs Ponds OU at a gradient of approximately 0.3%. An identifiable component of groundwater enters the OU from the southwest in the vicinity of the Opportunity Ponds. This system exhibits a gradient of approximately 0.7%. Large hydraulic head losses are evident across the berms which contain the Warm Springs Ponds.

The groundwater gradient is reversed (east to west) in the area between the Warm Springs Pond system and the bypass from the upper end of Pond 3 to below Pond 1. This indicates the bypass channel is gaining water from groundwater inflow in this reach and is acting as a line sink for the area's shallow groundwater system.

The groundwater gradient in Pond 1 appears to be affected by the presence of impounded water in the northeast corner of Pond 1. The presence of impounded water in Pond 1 alters groundwater flow lines in this vicinity in response to the artificially elevated surface water. The shallow groundwater system below Pond 1 is most likely partially intercepted by the Mill-Willow Bypass and the Clark Fork River.

40. Page 3-49, second bullet: Data from Well WSP-3 indicate a downward hydraulic gradient. This fact should be noted in the discussion that indicates upward gradients at Wells WSP-2, WSP-4, and WSP-5. An upward gradient is an indication of discharge from the aquifer and a downward gradient is an indication of recharge to the aquifer. The text notes artesian conditions were encountered during drilling of Well WSP-1. For artesian conditions to exist, a confining layer must

be present above and below the aquifer. This situation is not indicated by the geological logs. Conditions here are better described as artesian-like rather than purely artesian. The last sentence is misleading and contributes nothing to the discussion. The vertical hydraulic gradient between Wells WSP-2A and WSP-2B is approximately the same as the vertical hydraulic gradient between Wells WSP-4 and WSP-5 (i.e., 0.04). The vertical hydraulic gradient (not head difference) is the important parameter in this discussion.

Response: The assessment of groundwater gradients in the referenced monitoring wells and the mechanics of groundwater movement in response to them is correct. Evaluation of the geologic log for monitoring well WSP-1 indicates several fine-grained zones were encountered during drilling, including the following depths: 24-34 ft. (silty clay); 34-42 ft. (silty sand); and, 48-52 ft. (silty sand). The monitoring well also exhibited flowing water for a period of time following well construction. This information suggests the groundwater system characterized by this well (69 to 79 ft. below surface) is artesian.

As stated above, the vertical hydraulic gradient is the important consideration with regard to this statement. AMC's assessment does not, however, change Phase I RI results or conclusions.

41. Page 3-49, last sentence: this sentence is one instance where a definitive statement should be made. If the permeabilities are similar and the gradient is greater, by Darcy's Law more groundwater does move through the Opportunity Ponds and Warm Springs Creek system than in the case of a lower gradient.

Response: The word "probably" should be deleted from the last sentence on page 3-49.

42. Page 3-50, first paragraph: The presence of marshes and wetlands is overlooked in this part of the RI report. These features along with the referenced seeps are indications of a near-surface water table. The presence of springs is also overlooked in the RI as a whole. Springs are excellent sampling locations for water chemistry because they are discharge points for the aquifer.

Response: We agree the presence of marshes and wetlands in the vicinity of the Warm Springs Ponds is indicative of a near-surface water table. This is discussed in the RI document on page 1-7. Springs were not overlooked during the RI. Very few springs occur in the study area, and none were found in the vicinity of the Warm Springs Ponds.

43. Page 3-55, Line 22: MultiTech suggests that dissolved iron concentrations may correlate with other elevated metals, but no statistics are presented. Therefore, the statement is hypothetical.

Response: Again, the intent of the statement is not that dissolved iron is statistically correlatable to other metals parameters, but that the occurrence of elevated dissolved iron concentrations tracks directly with the occurrence of elevated concentrations of other metals parameters (e.g. arsenic). This type of obvious trend assessment need not be supported by statistical analysis.

44. Page 3-61, first paragraph: Elevated metals concentrations could also be the result of transport from natural mineralization.

Response: It is possible that localized elevated metals concentration could be the result of the transport of natural mineralization. This possibility, however, does not affect the conclusions reached in the Phase I RI.

45. Page 3-61, second paragraph: The sources for geochemical background should be cited.

Response: References for geochemical background concentrations in sediments are presented in Attachment C-3 to this document.

46. Page 3-63, third paragraph: This paragraph makes no sense. What does the similarity of concentrations between two laboratories have to do with water quality interpretation? Presumably what is meant is that the results of water analysis were similar between the two laboratories, giving more credence that the concentrations are accurate.

Response: The fact that two different laboratories generated similar analytical results from closely-spaced sampling intervals lends credibility to the concentrations given in Table 3-21 of the Phase I RI.

47. Page 3-65, first sentence: Define significant. Does it mean 1) largest concentration, 2) most potential for harm, 3) greatest variance from background, or 4) another interpretation?

Response: The intent of the sentence is to indicate that dissolved iron and arsenic exhibit both the highest concentrations and the greatest areal extent of parameters measured in the Warm Springs Ponds area.

48. Page 4-7, Section 4.2.1.2: This section indicates that the Warm Springs Ponds are a source of contamination to the groundwater system. In this section and the following section (Potential Sources of Contamination), no mention of natural sources is made. Such a source (hot springs) is briefly discussed on Page 3-60 under "Fluoride". The natural sources need to be included as part of these discussions.

Response: It is our contention that natural sources of groundwater contamination are not present in the immediate vicinity of the Warm Springs Ponds. This premise is based upon installation and sampling of three additional monitoring wells located upgradient of the pond system during the Warm Springs Ponds Phase II RI. Metals and fluoride concentrations in the four monitoring wells located upgradient (south) of the Warm Springs Ponds were low, generally below method detection limits. Average concentrations and ranges in concentration for selected parameters measured in the four upgradient wells are presented below:

Parameter	Conc. Range	Avg. Conc.
Fluoride	1.1-1.4 mg/L	1.2 mg/L
Aluminum	<90-<90 ug/L	<90 ug/L
Cadmium	<5-7 ug/L	5 ug/L
Copper	<8-<8 ug/L	<8 ug/L
Iron	<15-17 ug/L	15 ug/L
Lead	<1-1.2 ug/L	1 ug/L
Manganese	<3-22 ug/L	10 ug/L
Zinc	<13-<13 ug/L	<13 ug/L

49. Page 4-10, Line 9: Quantify the word "significantly". For example, is there a 10 percent, 50 percent, 100 percent, or other percent greater chance of failure?

Response: IECO did not provide a risk analysis of Warm Springs Ponds failure. Because of the factor of safety included in engineering designs, however, it can be assumed that there is little risk of failure at flows less than design flows, and that the risk of failure increases as the design flow is exceeded. The intent of the phrase "increases significantly" in this case is to indicate the increase in risk as the transition is made between these regimes.

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ATTACHMENT

C-1

TABLE 3-5
EFFICIENCY OF WARM SPRINGS PONDS FOR SULFATE REMOVAL

Period	Overall Efficiency			Pond 2 Efficiency		
	Inflow (1000 lbs)	Loss (1000 lbs)	Efficiency	Inflow (1000 lbs)	Loss (1000 lbs)	Efficiency
June 1-5	836	2	0%	735	-45	-6%
June 16-30	417	129	31%	221	-3	-1%
July 1-15	316	45	14%	176	-33	-19%
July 16-31	290	65	22%	143	14	10%
August 1-15	259	-216	-83%	288	-38	-13%
August 16-31	257	-43	-17%	208	-12	-6%
September 1-15	332	-142	-43%	311	-71	-23%
Total Period	2710	-160	-6%	2082	-188	-9%

TABLE 3-6
EFFICIENCY OF WARM SPRINGS PONDS FOR TOTAL IRON REMOVAL

Period	Overall Efficiency			Pond 2 Efficiency		
	Inflow (lbs)	Loss (lbs)	Efficiency	Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	845	576	68%	2423	1263	52%
June 16-30	4890	4820	99%	771	565	73%
July 1-15	2380	2130	89%	581	392	68%
July 16-31	1380	1180	85%	442	350	79%
August 1-15	2570	2150	84%	662	320	48%
August 16-31	1130	890	79%	539	295	55%
September 1-15	3110	2790	90%	184	-79	-43%
Total Period	16,300	14,500	89%	5,600	3,100	55%

TABLE 3-7
EFFICIENCY OF WARM SPRINGS PONDS FOR DISSOLVED IRON REMOVAL

Period	Overall Efficiency Inflow (lbs)	Loss (lbs)	Efficiency	Pond 2 Efficiency Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	222	-76	-34%	364	41	11%
June 16-30	91	>79	>87%	<58	<22	<38%
July 1-15	45	>72	>160%	<9.6	<-0.3	<-3%
July 16-31	183	>178	>97%	(a)	-	-
August 1-15(b)	74	-22	-29%	386	<343	<89%
August 16-31	86	>46	>53%	(a)	-	-
September 1-15	97	>74	>76%	(a)	-	-
Total Period(c)	798	>351	>44%			

(a) Calculation of Pond 2 efficiency not possible because both inflow and outflow were below detection.

(b) Gain of dissolved iron is due to an unlikely value measured at PS-11A.

(c) Calculated without data from August 1-15.

TABLE 3-8
EFFICIENCY OF WARM SPRINGS PONDS FOR TOTAL ZINC REMOVAL

Period	Overall Efficiency			Pond 2 Efficiency		
	Inflow (lbs)	Loss (lbs)	Efficiency	Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	4320	4050	94%	942	268	28%
June 16-30	1410	1450	103%	135	93	70%
July 1-15	1350	1240	92%	63	18	29%
July 16-31	805	752	93%	55	33	60%
August 1-15	1550	1510	98%	114	54	47%
August 16-31	942	922	98%	96	36	37%
September 1-15	2240	2160	97%	228	162	71%
Total Period	12,600	12,100	96%	1,633	664	41%

TABLE 3-9
EFFICIENCY OF WARM SPRINGS PONDS FOR DISSOLVED ZINC REMOVAL

	Overall Efficiency			Pond 2 Efficiency		
Period	Inflow (lbs)	Loss (lbs)	Efficiency	Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	2266	1991	88%	386	-60	-16%
June 16-30	137	>123	90%	(a)	-	-
July 1-15	173	>149	>86%	(a)	-	-
July 16-31	171	>138	>81%	<12.1	<4.1	<34%
August 1-15	876	>793	>91%	(a)	-	-%
August 16-31	145	>88	>61%	(a)	-	-%
September 1-15	799	>776	>97%	17.9	>3.5	>20%
Total Period	4,567	>4,058	>89%			

(a) Calculation of Pond 2 efficiency not possible because both inflow and outflow were below detection.

TABLE 3-10
EFFICIENCY OF WARM SPRINGS PONDS FOR TOTAL COPPER REMOVAL

	Overall Efficiency			Pond 2 Efficiency		
Period	Inflow (lbs)	Loss (lbs)	Efficiency	Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	1440	1350	93%	467	119	26%
June 16-30	484	448	93%	73	41	56%
July 1-15	629	510	81%	64	21	33%
July 16-31	305	279	91%	115	96	84%
August 1-15	612	670	109%	97	42	43%
August 16-31	286	390	136%	39	23	59%
September 1-15	824	778	94%	106	66	62%
Total Period	4,580	4,425	97%	961	408	42%

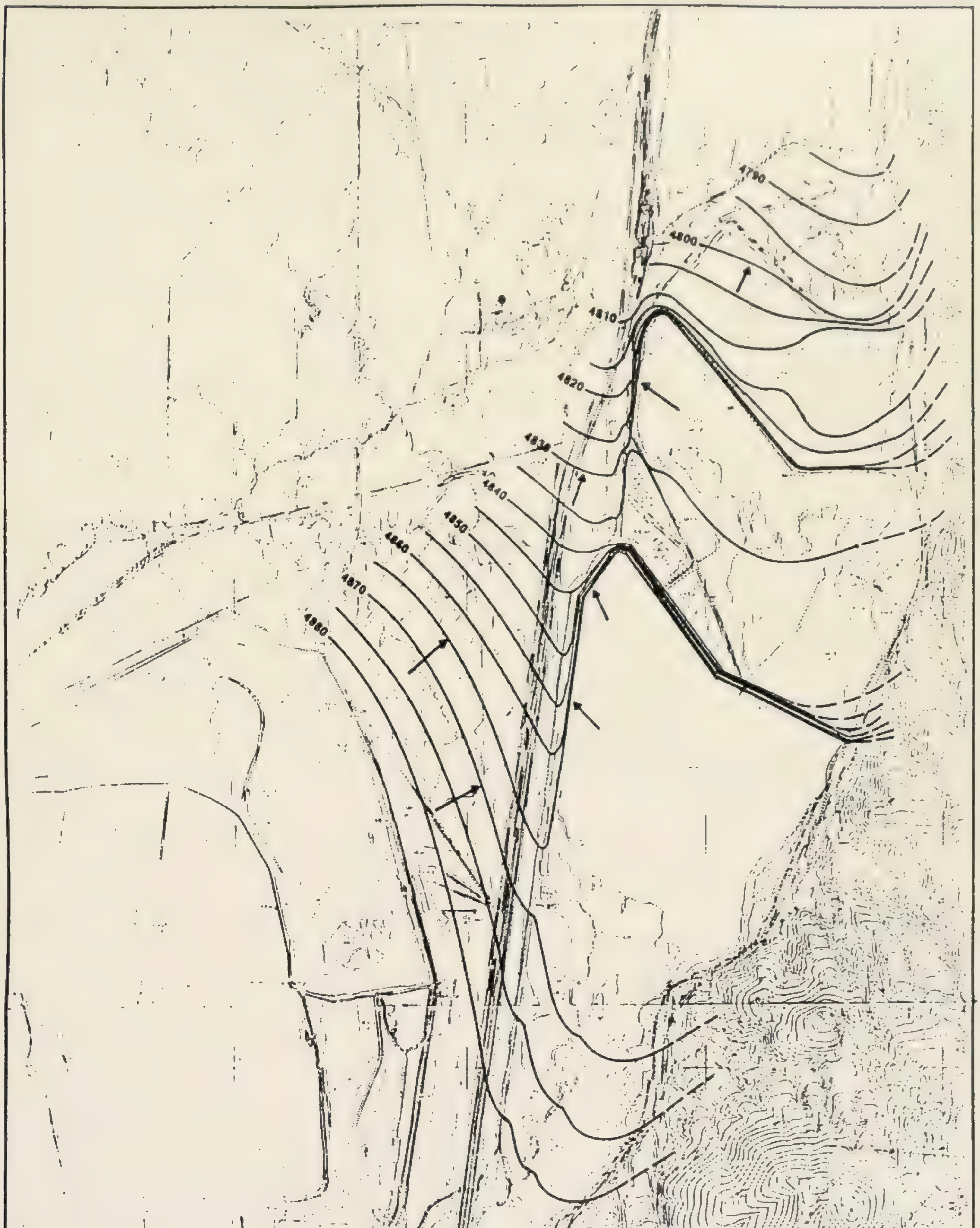
TABLE 3-11
EFFICIENCY OF WARM SPRINGS PONDS FOR DISSOLVED COPPER REMOVAL

	Overall Efficiency			Pond 2 Efficiency		
Period	Inflow (lbs)(a)	Loss (lbs)	Efficiency	Inflow (lbs)	Loss (lbs)	Efficiency
June 1-15	<433	>70	>16%	219	-131	-60%
June 16-30	<133	>81	>61%	(b)	-	-
July 1-15	<116	>86	>74%	(b)	-	-
July 16-31	<139	>109	>78%	(b)	-	-
August 1-15	<155	>99	>94%	(b)	-	-
August 16-31	<119	>75	>63%	(b)	-	-
September 1-15	<196	>144	>74%	(b)	-	-
Total Period	<1,291	>664	>51%			

(a) Lower bound of inflow load used in numerator; upper bound used in denominator.

(b) Calculation of Pond 2 efficiency not possible because both inflow and outflow were below detection.

ATTACHMENT C-2



LEGEND

DIRECTION OF GROUNDWATER MOVEMENT

0 2000
SCALE IN FEET

FIGURE 2-7

WATER TABLE MAP OF SHALLOW AQUIFER

WARM SPRINGS PONDS FEASIBILITY STUDY

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ATTACHMENT C-3

TABLE

SILVER BOW CREEK RI
BACKGROUND TOTAL CONCENTRATIONS OF ELEMENTS
IN SOIL AND SEDIMENTS

Source	Type of Material	Location	Cu	As	Cd	Pb	Zn	Mn
			---- (micrograms / gram) ----					
Parker (1967)	crust	U.S.	55	1.8	0.2	-	-	-
	ig. rocks	U.S.	100	5.0	0.5	-	-	-
Rose *et al.* (1979)	mafic rxs	U.S.	72	1.5	0.2	-	-	-
	soils	U.S.	15	7.5	0.3	-	-	-
Salomons & Forstner (1984)	soils	U.S.	25.8	11.3	0.6	-	-	-
Osborne *et al.* (1986)	Low Cr. Volc. rxs	Gregson	66.6	-	1.4	-	-	-
Osborne *et al.* (1986)	Basalt	Deer L.	72.2	-	9.7	-	-	-
Osborne *et al.* (1986)	Elk. vol.	Avon	157.0	-	2.0	-	-	-
	rhyolite	Avon	12.5	-	0.7	-	-	-
Woessner *et al.* (1984)	sediment	Milltown	35.0	10.0	0.4	17.0	90.0	265.
Rice & Ray (1985)	soils	Deer L.	51.0	20.0	1.7	-	-	-
TetraTech	soils 1"	Townsend	21.0	3.4	1.4	55.0	95.0	625.
	soils 6"	Townsend	17.0	3.2	0.4	18.0	66.0	532.
	soils 18"	Townsend	14.0	5.2	0.4	15.0	56.0	401.
Kabata-Pendias Pendias (1984)	soils	U.S.	6-60	6.7	0.07	20.0	20	495
		World	6-60	8.7	1.1	25.0	120	545
Lindsay (1979)	soils	World	30.0	5.0	0.06	10.0	50.0	600
Selected Regional Average	soils		100	20	1.6	60	100	600

ALGAE INVESTIGATION
(APPENDIX D, PART I)

OVERVIEW

An investigation was conducted by MultiTech and OEA Research (1986a) to determine the role of algae in transport of trace metals from the Warm Springs Ponds to the Upper Clark Fork River. The investigation consisted of the following items:

- o A general review of the literature concerning toxicity and bioaccumulation of trace metals in various algal taxa
- o A literature review of studies of algal community composition and abundances, and trace metal bioaccumulation by algae in the vicinity of Warm Springs Ponds
- o A hypothesis that algae in Warm Springs Ponds may act as a major transport pathway for trace metals, and may be used in the development of methods to reduce aqueous concentrations of trace metals.

General comments concerning each of these areas of the algae investigation are provided below.

GENERAL COMMENTS

<u>General Review of the Literature</u>

The review conducted by MultiTech and OEA Research (1986a) is based on the premise that pollution-sensitive taxa are absent or occur in relatively low abundances in areas affected by anthropogenic contaminants, and that

literature review are then used as an indication of trace metal accumulation and transport by conspecific or congeneric algal taxa in the vicinity of Warm Springs Ponds. Note that BCFs are typically derived from controlled laboratory experiments, or highly detailed field investigations that are specifically designed to determine the bioaccumulation potential of contaminants. Thus, the BCFs derived by MultiTech and OEA Research (1986a) are based on extrapolations that are of questionable validity.

MultiTech and OEA Research's (1986a) evaluation of algal-mediated bioaccumulation and transport of trace metals is also based on the premise (p. iii and p. 3-30 in Appendix D, Part 1 of the RI Report) that such a process may be harnessed in development of a control technology to decrease trace metal loadings to the Upper Clark Fork River. MultiTech and OEA Research (1986a) cite a field study where concentrations of trace metals in smelter effluent were reduced after flowing through a receiving channel and a sedimentation basin. Although the receiving channel was populated by an alga (Cladophora) that is capable of bioaccumulating trace metals, the proportion of trace metal removal that was attributable to bioaccumulation is not described. Presumably, trace metals were also removed by geochemical processes such as sorption to particles, coprecipitation with hydrous iron and manganese oxides and carbonates, and complexation and flocculation with detrital organic matter. MultiTech and OEA Research (1986a) also cite a recent study that showed that cultured cells of a planktonic alga (Chlorella vulgaris) could be freeze dried, immobilized in a polyacrylamide gel, packed into a column, and used as an ion-exchange medium at pH 5-7 to remove metal ions from solution. Although this process appears to have potential for highly controlled industrial applications, MultiTech and OEA Research (1986a) did not indicate how such a process could be applied to Silver Bow Creek where trace metals in the water column exist in various states of complexation, and are highly variable in space and time. In conclusion, the appropriateness of even mentioning such an approach remains to be demonstrated for site-specific conditions in the vicinity of Warm Springs Ponds.

Algal Communities and Bioaccumulation in the Vicinity of Warm Springs Ponds

MultiTech and OEA Research (1986a) reviewed several site-specific studies of principally periphyton (i.e., nonplanktonic algae) communities in the vicinity of Silver Bow Creek, Warm Springs Ponds, and the Upper Clark Fork River (Table 3-3 in Appendix D, Part 1 of the RI report). Inspection of these data indicates a much greater diversity of algal taxa in Silver Bow Creek than in Warm Springs Ponds or the Upper Clark Fork River. However, it should be recognized that fundamental differences exist among biotic communities in lotic (i.e., running water)/habitats such as Silver Bow Creek as compared to lentic (i.e., standing water)habitats such as Warm Springs Ponds (Hynes 1970). Consequently, potential impacts to the existing algal communities in Silver Bow Creek, Warm Springs Ponds, and the Upper Clark Fork River cannot be meaningfully deduced without similar information for comparable control or reference habitats.

Concentrations of three trace metals (copper, cadmium, and arsenic) in periphyton from the Warm Springs Ponds were measured in October 1984 (deRuiter 1984). Concentrations of all three trace metals in algae decreased in a downstream direction (Table 1-1 in Appendix D, Part 1 of the RI report). According to MultiTech and OEA Research (1986a), these data indicate that algae in Warm Springs Ponds concentrate metals from the aquatic environment. However, there is disagreement over the pathway leading to trace metal bioaccumulation. MultiTech and OEA Research (1986a) indicate that the primary pathway is uptake of trace metals from water, whereas deRuiter (1984) indicates that the primary exposure pathway is through periphyton contact with sediments. Based on MultiTech and OEA Research's (1986a) summary, neither viewpoint, nor the validity of the study results, can be adequately assessed. The following information is needed to evaluate deRuiter's (1984) results:

- Indication of whether metals concentrations in periphyton are expressed on a wet-weight or a dry-weight basis

- Description of sample collection and processing methods that preclude cross-contamination with sediment-bound trace metals

- Summary of trace metal concentrations in water and sediments at each collection site

- Identification of the algal species used to assess trace metal bioaccumulation

- Comparable data set for an uncontaminated reference area.

Phytoplankton concentrations in Warm Springs Ponds 2 and 3, and in the pond discharges were measured intermittently by various investigations during March-May 1985 (Table 3-4 in Appendix D, Part 1 of the RI report). Streamflow measurements, pond discharge rates, concentrations of total suspended solids, and concentrations of zinc, copper, and iron in total and dissolved fractions were also measured at biweekly intervals during March-May 1985. Details of methods used for sample collection, processing, and analysis are not discussed by MultiTech and OEA Research (1986a). Consequently, the appropriateness of sampling and analytical methods cannot be determined from the available information.

Phytoplankton concentrations ranged from 9,450 to 31,450 cells/mL in Pond 3, and from 1,200 to 92,228 cells/mL in Pond 2 (Table 3-4 in Appendix D, Part 1 of the RI report). Dominant phytoplankton genera were <u>Chlorellaeu and</u> <u>Chlamydomona</u> in Pond 3, and <u>Chlorella</u>, <u>Fragilaria</u>, <u>Pediastrum</u>, and an unidentified flagellate in Pond 2. MultiTech and OEA Research (1986a) show that temporal trends in phytoplankton concentrations and total suspended solids concentrations in the Pond 2 discharge are in general agreement with one another. There were too few data to establish, even qualitatively, a relationship between phytoplankon concentrations and total suspended solids concentrations at other sampling locations where phytoplankton were only sampled on one or two occasions. MultiTech and OEA Research (1986a) do not indicate how these trends may be used to elucidate impacts on algal communities or define algal mediated transport

of trace metals to the upper Clark Fork River. Consequently, further clarification and interpretation of this aspect of the algal investigation should be provided.

MultiTech and OEA Research (1986) also state (p.3-30) that in Pond 2, "algae concentrations are higher in the discharge (58,275 cells/mL) than in the pond (37,125 cells/mL) based upon samples taken on April 24, 1985." This observation is used to form a generalization concerning the potential importance of sedimentation of particle-bound trace metals in comparison with downstream transport of trace metals in algae. Note that the differences in phytoplankton abundances between the pond and the pond discharge are small and may not be significant in a statistical sense. Phytoplankton cell densities are notoriously variable, and require a high degree of sample replication to make meaningful spatial and temporal comparisons. Consequently, the validity of MultiTech and OEA Research's (1986a) observation cannot be assessed because details of sample replication and statistical comparisons are not provided.

Trace metal concentrations in the dissolved fraction are not reported by MultiTech and OEA Research (1986a) because dissolved "concentrations were at or below detection limits for the period of interest." However, MultiTech and OEA Research (1986a) indicate that total trace metals concentrations were generally correlated with total suspended solids at the various sampling locations. The quantitative basis of this conclusion is not provided by MultiTech and OEA Research (1986a). Presumably, "correlation" is used in a qualitative (i.e., nonstatistical) manner to indicate a general agreement in temporal trends in concentrations of total suspended solids and trace metals. Inspection of the data indicates similar temporal trends in concentrations of total suspended solids and total trace metals in Ponds 2 and 3, but not in the pond discharges (see Figures 3-1 to 3-5 in Appendix D, Part 1 of the RI report). MultiTech and OEA Research (1986a) do not indicate how these trends may be used to elucidate impacts on algal communities or define algal mediated transport of trace metals to the Upper Clark Fork River. Consequently, further clarification and interpretation of this aspect of the algal investigation should be provided.

MultiTech and OEA Research (1986a) also indicate (p. 3-30) that total suspended solids and trace metal concentrations were higher in the ponds than in the pond discharges. Presumably, this conclusion is based on a summary of peak values for total suspended solids and trace metals concentrations in Pond 2 and in the discharge from Pond 2 (Table 3-5 in Appendix D, Part 1 of the RI report). However, these comparisons may not be valid because the peak values for total suspended solids and trace metal concentrations in Pond 2 occurred on different sampling dates than those in the discharge from Pond 2. Also, note that consistent differences in total suspended solids and trace metal concentrations between the ponds and the pond discharges are not evident in MultiTech and OEA Research's (1986a) temporal representation of these data (see Figures 3-1 to 3-5 in Appendix D, Part 1 of the RI report).

Algal Bioaccumulation as a Major Transport Pathway for Trace Metals

MultiTech and OEA Research (1986a) offer the following lines of evidence to support a hypothesis that trace metal accumulation by algae may act as a major pathway for trace metal transport in Warm Springs Ponds:

- o A review of the literature indicates that a number of algal species bioconcentrate trace metals from the water column

- o A number of algal species that are known to bioaccumulate trace metals have been observed in the Warm Springs Ponds system

- o The 1985 survey of phytoplankton communities in Warm Springs Ponds "show a strong relationship between trace metal and [total suspended solids] concentrations"

- o The 1985 survey of phytoplankton communities in Warm Springs "Pond 2 and its discharge indicate that the peak in algal numbers probably occurs at roughly the same time as the peaks in [total suspended solids] and trace metals within the pond"

- o Although phytoplankton concentrations are higher in the pond discharges than in the ponds, most of the phytoplankton appear to be retained in the ponds

- o Total suspended solids and trace metal concentrations are lower in the discharges than in the ponds.

MultiTech and OEA Research (1986a) speculate (p.3-30) that "algae may be increasing in numbers during late winter-early spring (accounting for increases in total suspended solids) and concentrating trace metals from the incoming water, but are being retained to some extent within the ponds". MultiTech and OEA Research (1986a) also indicate that sedimentation of trace-metal bearing particles may account for lower concentrations of total suspended solids and trace metals in the ponds than in the pond discharges. MultiTech and OEA Research (1986a) conclude (p. 4-1) that "a reasonable argument can be made that during spring 1985 algae in Warm Springs Pond 2 took metals out of the water entering the ponds and that most of the algae were retained within the pond". Although MultiTech and OEA Research (1986a) acknowledge that the data supporting this argument are limited, they nevertheless propose to conduct a study to:

- o Develop a metals budget for one of the ponds to determine whether metals removal from the pond is associated with algal blooms

- o Perform experiments with algal cultures grown in water from the ponds and algal cultures grown in suitable control media to determine the role that algae "play in metal segregation and transport".

These conclusions are based on limited data, grossly qualitative analyses, and a loosely-assembled assortment of potential relationships that far exceed the limits of credible scientific reasoning. For example, the "strong relationship" between trace metals and total suspended solids is

not proven quantitatively. Although such a relationship may exist, it is likely that it would be highly variable and dependent on numerous seasonal factors that affect suspended solids concentrations, and the relative proportions of dissolved and particle-bound trace metals. Assuming such a relationship exists, data must be gathered that clearly indicate that phytoplankton comprise a significant, and quantifiable, proportion of the total suspended solids. It must also be clearly demonstrated that rates of trace metals bioaccumulation are sufficiently high to account for a meaningful proportion of trace metal mass loadings into the Warm Springs Ponds. Variables that need to be considered in this analysis are bioavailability of each trace metal species in the dissolved and particulate fractions, temporal variation in abundance and productivity of algal populations, and rates of trace metal accumulation, which may be enormously variable. Note that each of these questions form the basis of fundamental research problems that may not be easily answered within the scope of the studies proposed by MultiTech and OEA Research (1986a).

A more fruitful exercise would be to develop a quantitative model from existing information. Such an approach would serve to identify data gaps and provide an order of magnitude determination of the reasonableness of trace metal accumulation by algae as a major transport mechanism. Finally, it should be considered whether such an evaluation is even meaningful in the context of an RI/FS. Assuming that a significant proportion of trace-metal loadings are partitioned among periphyton and phytoplankton communities, how will this knowledge be used in the development of remedial alternatives that can be realistically considered in the FS? Would the range of remedial alternatives for the site be any different if it was assumed that phytoplankton communities are a component of the total suspended solids, and that periphyton communities are a component of the sedimentary environment?

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: The reviewer raises a number of valid issues and questions regarding conclusions reached in the algae investigation, as well as the applicability of results from this study and any future algal investigations. Authors of the original report present an argument that may reflect what is actually happening in the Warm Springs Ponds in terms of metals uptake and transport by algae. However, by their own admission, "data supporting this argument are limited".

Because of the very few data, conclusions reached in the original report are largely speculative. The Executive Summary section of the original report acknowledges the relatively weak data base in stating "the limited nature of this study did not allow a quantitative assessment of metals transport". The authors suggested two approaches, (field and laboratory) for providing a more comprehensive evaluation of metals uptake and transport by algae, but only "if algae are seriously considered as a remedial control technology for the Silver Bow Creek CERCLA site". While at this time the remedial alternatives being considered for the Warm Springs Ponds do not include the pond system, more detailed studies will be conducted to determine if there are any beneficial biological effects which can be taken advantage of.

RIPARIAN VEGETATION MAPPING OF SILVER BOW CREEK AND THE UPPER CLARK FORK RIVER (APPENDIX D, PART 2)

OVERVIEW

The purpose of the riparian vegetation study was to map the distribution of tailings and vegetation types in the floodplains of Silver Bow Creek (and its tributaries) and the upper Clark Fork River. MultiTech states that the information on the distribution of tailings will be used in the Feasibility Study (FS) to "identify operable units; identify potential corrective action sites; and characterize contaminant sources". Information from the vegetation mapping is to be used to "identify potential treatment facility locations and potential borrow areas".

Previous studies of vegetation in the region are described in the riparian vegetation report. Major species occurring in each major area of the site are listed by MultiTech, and the degree of disturbance of riparian vegetation is discussed. MultiTech used aerial photographs to map tailings deposits and vegetation types. Mapping units were defined according to the classification system for riparian vegetation presented by Batchelor et al. (1982), with additional units defined for unvegetated areas. Fourteen different mapping-unit categories were used. MultiTech states that the photographs and map overlays were "verified" in the field. Ten maps were developed from the analysis and included with the riparian vegetation report. These maps were not available for this review.

GENERAL COMMENTS

First Paragraph First Sentence Comment

MultiTech provides no discussion of a number of issues that are relevant to vegetation for an RI, as described in the appropriate guidance document (U.S. EPA 1985b).

Response: USEPA guidelines were not set when MultiTech developed its RI Work Plan. It is assumed that AMC reviewed the RI Work Plan before the work was conducted.

First Paragraph Second Sentence Comment

These issues include the following:

- o Possible existence of critical habitats in the study area
- o Possible presence of threatened or endangered plant species in the study area.

Response: MultiTech did not identify critical habitats, or the presence of threatened or endangered plant species, apparently because these issues were not identified in EPA's guidelines before the development of the RI work plan. MultiTech's stated objective was "to map the tailings and riparian vegetation at the largest possible scale, using easily recognizable mapping units that differentiated the riparian vegetation of the site".

Second Paragraph Second and Third Sentence Comment

MultiTech indicates on pages 1-1 and 1-4 that the maps of tailings deposits and riparian vegetation will be used to identify both areas that may require remedial action ("potential corrective action sites") and areas for which reclamation is feasible ("operable units"), as well as to "characterize contaminant sources".

Two aspects of the mapping procedures may potentially limit the usefulness of the maps for identifying areas that may need remediation and for planning remedial actions. First, the locations and sizes of areas of tailings that are covered by other material are apparently not indicated on the maps.

Response: MultiTech acknowledged that its method (aerial photography) did not indicate the location and sizes of tailings covered by other materials, and thus, its figure of 1,133 visible acres underestimates the total extent of tailings deposits.

Second Paragraph Fourth and Fifth Sentence Comment

Second, MultiTech failed to distinguish standing, dead vegetation from living vegetation. Information on the condition of vegetation would be useful both for evaluating the need for specific remedial actions and for developing appropriate reclamation techniques. The presence of dead, woody vegetation may indicate phytoxic conditions, and a list of plants surviving on such sites could be used for planning revegetation, if appropriate.

Response: MultiTech found it difficult to map these zones as a single unit, indicating that scattered individuals or small groups are affected. This suggests that the woody vegetation is dying because of one or more of a number of iotic or abiotic causes. Phytotoxic tailings materials would not be so selective or distributed on such a small scale.

A list of plant species that have grown or are currently growing in areas with mine and mill tailings would be useful to select appropriate species for revegetation, but such information is not necessary to determine the nature and extent of contamination at the Silver Bow Creek CERCLA Site and meet the needs of an appropriate RI.

Third Paragraph Comment

It is not clear to what conditions MultiTech was referring when they describe areas "containing less than complete phytotoxic concentrations of contaminants". If these were plant community types that are both distinct and known to be representative of phytotoxic conditions in soils, mapping them would have provided useful information for evaluating the extent and nature of soil contamination, a major purpose of an RI.

Response: The statement "Areas of the floodplain ... containing less than complete phytotoxic concentrations of contaminants" is somewhat unclear. This statement refers to soil metal concentrations, and may or may not be represented by unique vegetation assemblages. MultiTech stated that "some of these areas were identified on aerial photography...".

These identifiable plant communities should have been mapped as separate units if these community types were distinct and represented phytotoxic conditions in soils. Such information would help determine the nature and extent of contamination at Silver Bow Creek. However, a link between distinct community types and particular phytotoxic levels would have to be established. Soil metal concentrations may or may not be represented by unique vegetation assemblages.

Fourth Paragraph First Sentence Comment

MultiTech does not describe in any detail the methods used to distinguish each of the different vegetation types on the aerial photographs or how the mapping units were "verified" in the field.

Response: The different vegetation types were identified on the aerial photographs by delineating areas that appear similar. The following items were taken into account when identifying like areas:

- color
- height of vegetation
- density of vegetation
- topographic location

Field verification entailed locating the identified areas on the ground and verifying that the plant species are indeed similar for comparable sites.

Fourth Paragraph, Second Sentence Comment

For example, how was disturbed vegetation (Mapping Unit IVA-2) identified?

> Response: The IVA-2 vegetation type refers to species occurring on disturbed soil, not to disturbed vegetation.

Fourth Paragraph, Third Sentence Comment

How was variability within mapping unit categories of vegetation dealt with in the field verification?

> Response: Unless a mapping unit category focuses on individual plants, there will always be variability within mapping unit categories. MultiTech addressed this variability implicitly by defining units based on dominance of certain growth forms or species, or lack thereof.

Fourth Paragraph, Last Sentence Comment

Additional information on mapping procedures would be needed to evaluate the accuracy of the mapping results.

> Response: To determine the accuracy of the mapping, which was done using aerial photographs, would involve the field truthing of the maps. Field truthing of these general maps was outside the scope of the mapping that was undertaken.

Fifth Paragraph Comment

In the Executive Summary, MultiTech states that the "information developed during this investigation can be used for the identification of borrow areas, reclamation sites, and reclamation species", and that the "information will be useful for the preparation of reclamation plans". While this information will be useful in this regard, additional information may be necessary for the stated purposes. For example, information on percent plant cover, vigor of existing plants, and soil conditions may also be needed to identify sites for remedial action. MultiTech does not discuss either the quality of the information actually collected or limits to its use.

Response: MultiTech does not suggest that the results of the RI are all that are needed "for the identification of borrow areas, reclamation sites, and reclamation species". MultiTech's statements (4-1, Summary 1-6) suggest that further information will be needed, such as percent plant cover, plant vigor and soil conditions, but these parameters were not incorporated in the Phase I RI Work Plan.

The purpose of a RI is to determine the nature and extent of contamination of a site. Whereas "information on percent plant cover, vigor of existing plants, and soil conditions may also be needed to identify sites for remedial action", they are not necessary to determine the nature and extent of contamination.

MultiTech does not "discuss the quality of the information actually collected or limits to its use". In any study, however, it would be inappropriate for the investigator to bias the reader by stating his or her opinion on the quality of the information or limits to its use. If properly informed of a study's objectives, design, and methods, the reader should determine the quality of the information and limits to its use.

Sixth Paragraph, First Three Sentences Comments

Although MultiTech states on page 1-4 that "previous studies by Hydrometrics (1983a, b, c) and Nehr and Weisel (1977) adequately documented those riparian species that are tolerant of contaminated conditions", a review of these reports revealed that the authors felt that this knowledge was not complete. The Hydrometrics studies were conducted at a reconnaissance level, and may not have been comprehensive enough to provide the needed information. In fact, Hydrometrics (1983a) recommended that experimental plots be established to test appropriate species for use in revegetation on different types of substrate.

> Response: The purpose of the Phase 1 RI was a broad assessment of the nature and extent of contamination of the site. Thus, MultiTech's main objectives in the RI Work Plan were to document "the location and extent of tailings deposits" and "mapping of the riparian vegetation". MultiTech's mapping units "were to be broad-based, easily recognizable types". This information "can be used for the identification of borrow areas, reclamation sites" and possibly "and reclamation species". For this latter objective, MultiTech relies on the surveys of Hydrometrics (1983 a,b,c) and Neher and Weisel (1977). These surveys may not be comprehensive enough to provide information for actual site remediation. For example, on most of the site species lists, several taxa have not been identified to species. Such information and experimental plots as recommended by Hydrometrics would be needed for any reclamation effort, but they were not necessary to determine the nature and extent of contamination.

Sixth Paragraph, Last Sentence Comment

MultiTech neither provides a discussion of past reclamation efforts, if there have been any, nor discusses the need for or potential for reclamation in the floodplain areas.

Response: The vegetation mapping component of the RI documents the extent of contamination at the site. It would be more appropriate to review past reclamation efforts, and to discuss "the need for or potential for reclamation in floodplain areas" in the Feasibility Study, rather than the RI.

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: No response needed.

AGRICULTURE INVESTIGATION
APPENDIX D, PART 3

OVERVIEW

The Agriculture Investigation report is presented as Appendix D of the Silver Bow Creek draft RI report, that was submitted by MultiTech (1987c) to the Montana Department of Health and Environmental Sciences in April 1987. The investigation was conducted to evaluate the extent and severity of potentially contaminated cropland that resulted from using irrigation waters from Silver Bow Creek or the Clark Fork River.

GENERAL COMMENTS

First Paragraph Comments

Soil profile sites were categorized as being either "upgradient" or "downgradient" from a hypothesized source of waterborne heavy metals. These categories were based on pH, total and soluble sulfur, acid digestible and extractable heavy metals concentrations in soils, and total heavy metal concentrations in plant material. However, the sites were not evaluated based on soil profile considerations. Many of the sites were located in floodplain sediments or within existing tailings deposits. These sites should not have been evaluated for impacts resulting from irrigating with Silver Bow Creek or Clark Fork water, but rather as part of a floodplain study. The presence of tailings deposits in some of the study areas must be considered before a meaningful analysis can be performed on the impacts of using Silver Bow Creek or Clark Fork water for irrigation upon these areas.

> Response: The primary contention of the general comments section is that not all sites sampled on agricultural land were in upland landscape positions where irrigation water was the source of contaminants. Some of the sites were located in floodplain areas.

Substantial clarification of the study results would result by improving the statement of objectives for the Agricultural Lands Investigation. The soil sampling plan was designed with two primary objectives in mind:

1) Was irrigation water a historical source of contamination of agricultural lands located above the floodplain (in upland positions)?

2) What was the severity of contamination on agricultural lands (both floodplain and upland), as judged by soil and plant tissue metal levels?

We agree that soil and plant tissue metals data from floodplain areas should have only been used to address the second objective. Samples collected from upland areas were generally paired in "upgradient" and "downgradient" positions relative to historical irrigation ditches. These data pairs are useful in addressing the first objective.

The relative landscape position of all sites sampled is shown below.

SITE	LANDOWNER	LANDSCAPE POSITION*	UPGRADIENT/ DOWNGRADIENT
A10	Thurmonds	U	----
A11	Thurmonds	F	----
A1	Konda	U	up
A2	Konda	U	down
A3	Konda	F	----
T12	Peterson	U	up
T13	Peterson	U	down
T14	Peterson	U	up
T15	Peterson	U	down
T17	Peterson	U	up
T16	Peterson	U	down
A6	Spangler	U	up
A7	Spangler	U	down
A12	Foresons	U	up
A13	Foresons	U	down
A9	Dutton	F	----

*U - Upland, historically irrigated
F - Floodplain Area

Hence, of sixteen sites sampled, there were six sets of paired samples in upgradient/downgradient positions which are valid for use in assessing the relative contribution of irrigation ditches as a source of contamination of upland surfaces.

SPECIFIC COMMENTS

1. Page 3-1, Line 21: The soil samples from Thurmond's site all indicated that this site consisted of a horizon that contained a mixture of mill tailings and alluvial material. Why was this site included in the analysis? How can the impact of trace elements due to irrigation be assessed?

   Response: Analysis of Thurmond's site is useful for assessing the severity of impact of contamination on agricultural systems. Many floodplain areas are used for irrigated agricultural production or as grazing systems along the Silver Bow/Clark Fork corridor; hence, the impact of floodplain contaminants is also of potential concern. The focus of the Agricultural Lands Investigation is on all agricultural lands, not just irrigated upland areas.

2. Page 3-5, Line 2: The total concentrations of arsenic, cadmium, copper, lead, and zinc exceeded "their respective geochemical background levels." These levels were established for background, non-impacted soils. Why were the data from this site used to evaluate irrigation practices on non-impacted sites?

   Response: The finding that elevated heavy metal levels were found in agricultural soils and in plant tissue of plants used for forage indicates that there may be a potential for adverse effects on human health or the environment. The significance of this finding is not lessened because the site is in a floodplain area. Hence, the source of contaminants on this site was from fluvial transport of mine waste within the floodplain, not through conveyance in irrigation ditches.

3. Page 3-6, Line 13: Konda Site A3 was located in an existing flood channel. Why was this site included in the study to evaluated irrigation practices?

<u>Response</u>: In MultiTech's RI Work Plan on Silver Bow Creek, agricultural systems (p 2-68), it is stated that "These investigations will be implemented using a two phased approach. The first phase will be a reconnaissance study to evaluate the approximate areal extent and severity of 'heavy metal' contamination effects on irrigated croplands and livestock". Two pages later, it is stated, "In regards to soils and crops, two objectives are proposed. The primary objective is the identification, demarcation, and pertinent investigation of those irrigated lands affected currently and/or historically by use of 'heavy metal' contaminated water(s)". In its first statement, MultiTech is not specific about the <u>source</u> of heavy metal contamination; in its second, MultiTech specifies contaminated water(s). MultiTech's study design and subsequent results incorporate agricultural lands affected by irrigation (from wells and Silver Bow Creek/Clark Fork River), floodplain sediments, and tailings deposits. Thus, the Phase I RI was intended to investigate agricultural lands contaminated by heavy metals, <u>regardless</u> of <u>source</u>.

4. Page 3-43, Line 20: Dutton Site A9 was located in the "west-facing floodplain of the Clark Fork River." Further on in this paragraph it is noted that mill tailings overlay an older surface horizon. Why was this site chosen to evaluate irrigation impacts?

<u>Response</u>: This site was chosen by MultiTech because of its dominant land use - agriculture, regardless of the three potential sources of contaminants: irrigation waters, floodplain sediments, and mill tailings.

5. Page 3-50, Line 18 (last bullet): The finding that "soil and plant heavy metals are more frequently elevated in the downgradient than upgradient sites" appears to be a function of the location of the

soil profiles not irrigation practices. These sites were generally located in tailings deposits or the floodplain of Silver Bow Creek or the Clark Fork River. Why were these sites included in this report on the effects of irrigation practices?

Response: We disagree. Refer to the Table following the general comments (p. D-21) and note that there are six sets of paired soil samples sites above and below ditches in upland positions which allow us to infer the likelihood that irrigation ditches were a historical source of contamination. We have not stated that all historically irrigated areas are contaminated, nor is this likely to be the case. However, at least in some areas where ditches were used to deliver water to fields (rather than just to convey water), substantial contamination has resulted. Identification of the extent of contamination will be provided through additional remedial investigations if the Public Health and Environmental Assessment identifies a potential health or environmental risk.

6. Page 4-1, Line 1: The conclusion that "waterborne heavy metal contamination, originating from upstream mining/mineral processing activities, have adversely affected agricultural activities within the study area" is misleading. This statement implies only the use of irrigated waters and not floodplain sediments as was the case in the study. Why isn't a statement included that states that floodplain sediments were used in the analyses?

   Response: Technically, waterborne heavy metals contaminant originating from upstream mining/mineral processing activities "includes metals in irrigation waters and floodplain sediments". MultiTech should have been more explicit by stating that there were multiple contributing sources, rather than using the general term "waterborne" contaminants.

7. Page 4-3, Line 1: Does the interpretation of "approximately 5,400 acres of clearly affected lands" include floodplain deposits or is this solely irrigable lands adjacent to the floodplain? If this

analysis includes floodplain deposits or non-irrigated lands, why was it included? Why were no maps or aerial photographs presented to verify the distribution of acreage?

Response: A task to formally identify the extent of contamination of agricultural lands will be initiated under the on-going RI if the Public Health and Environmental Assessment identifies a potential health or environmental risk. This phased approach is consistent with the consensus of the original Phase I RI team and is the most cost-effective manner in which to conduct a RI. The findings in the Agricultural Investigation were based on a review of historic and recent aerial photos and pertain to upland areas historically used for investigation.

8. Page 4-4, Line 4: The procedure used to average the acid-extractable trace element concentrations for given increments over depth are incorrect. The concentrations should have been depth-weighted averages. These values should be corrected.

   Response: The concentrations should have been depth-weighted averages, however it is believed these new data will not alter the conclusions in the Phase I RI. These data will be recalculated into proper depth weighted averages if these data are needed to enforce conclusions for a future feasibility study.

9. Page 4-11 through 4-15: Why was this information provided? The report is a remedial investigation, not a feasibility study.

   Response: Based on the results of the Silver Bow Creek Agriculture Investigation, MultiTech recommended a "three-tasked approach...for follow-on work". It is unclear whether MultiTech intended for this work to be conducted before or in conjunction with a Feasibility Study. The information was probably provided to inform the reader that the list of "reclamation-related parameters tested for was by no means exhaustive".

MACROINVERTEBRATE INVESTIGATION
(APPENDIX E., PART 1)

OVERVIEW

Benthic macroinvertebrate data for Silver Bow Creek and the Upper Clark Fork River were compiled from a variety of sources and reviewed by MultiTech and OEA Research (1986b). The various invertebrate studies were conducted over a 26-year period from 1959 to 1984, and ranged widely in study design, sampling methods, and analytical procedures. Consequently, the analysis of benthic invertebrate communities in the RI report was based on only those studies that were conducted at the same time of year, and that used comparable methods, station locations, and taxonomic procedures. Overall, the study evaluation and data selection criteria used by MultiTech and OEA Research (1986b) were appropriate. The studies selected for characterization of temporal and spatial trends in benthic invertebrate communities were those of Dent (1976), Harner-White Ecological Consultants (1982), and Chadwick and Associates (1983, 1984, 1985). These studies were conducted from 1972 to 1984, and sponsored by the Anaconda Minerals Company. The remaining studies, including those conducted by the U.S. EPA, were used for corroborative purposes only.

GENERAL COMMENTS

First Paragraph Comment

Quantitative analysis of the macroinvertebrate data consisted of graphical comparisons of temporal and spatial trends in total densities (i.e., numbers of organisms/m^2) and species richness (i.e., numbers of taxa) of aquatic insects at six stations located in Silver Bow Creek, three stations located in the Upper Clark Fork River, and one reference station located in Mill-Willow Creek. Additional variables considered were Shannon-Weiner diversity, and, qualitatively, relative abundances of

individual species, higher taxonomic groups, or trophic groups that may be indicative of environmental impacts. Values of the Shannon-Weiner diversity index were used to assess community impacts by comparison with a range of values that are representative of insect species diversity in unpolluted environments (diversity range of 2.6-4.0) and polluted environments (diversity values <2.0).

Response: No response required.

Second Paragraph Comment

Overall, the comparative approach adopted by MultiTech and OEA Research (1986b) was appropriate for the quality of data available for evaluation. The major limitation was the lack of sample replication for macrobenthic surveys conducted between 1972 and 1980, which precludes statistical comparisons. However, reliance on the Shannon-Weiner diversity index to judge impacted areas is inappropriate in most cases because taxonomic identifications were only made to the family level for the studies conducted between 1972 and 1978, and were only carried out to the species level thereafter. The Shannon-Weiner diversity index is intended for evaluation of community structure based on species level identifications. Diversity calculations based on family level taxonomy may grossly underestimate actual diversity based on species level taxonomy (Wu 1982). Thus, the Shannon-Weiner diversity values for surveys conducted between 1972 and 1978 cannot be compared meaningfully with diversity values for subsequent survey dates, nor with the baseline range of diversity values that is presumably representative of unpolluted conditions.

Response: This paragraph contains a good discussion of the intended use of the Shannon-Weiner diversity index and misinterpretations that can result from comparing diversity indices based on different levels of taxonomic identification (i.e., family versus species). Authors of the original report were aware of the family (or order) level of identification used in 1972 through 1978 field studies and

the species (or genus) level of identification used in 1979 through 1984 field studies. This was pointed out at various places in their report (e.g., pages 2-1, 2-8, 2-9, and 2-10, and Table 3-1 on page 3-5).

The original report incorrectly compared family-based and species-based diversity indices for Clark Fork River stations I, J, and K over the period 1972 through 1984. This comparison is invalid and cannot be used in concluding that diversity has been increasing at these three stations, as was concluded in the original report. Several exceptions to our overall agreement with the reviewers critique are discussed below:

- o Diversity indices at Silver Bow Creek stations A and C were comparable to values at many of the Clark Fork River stations.

- o Diversity at Silver Bow Creek station E was less than at stations A and C.

- o Station E in the Mill-Willow Bypass (reported to be AMC's control station) had the highest diversity of stations sampled.

- o Diversity indices at Clark Fork River stations G and H were less than at Clark Fork River stations I and K.

<u>Third Paragraph First Bullet Comment</u>:

Based on their analysis of temporal trends in community composition and abundances in the Clark Fork River, MultiTech and OEA Research (1986b) concluded that:

- o The recovery of insect communities in the Upper Clark Fork River is 8-10 year further advanced than that in Silver Bow Creek.

Response: Authors of the original report concluded that "The Clark Fork River is further in the recovery process than Silver Bow Creek" and that "The reactivation of liming at Warm Springs Ponds 2 and 3 in 1963-1964 . . . gave the Clark Fork an eight to ten year headstart on the recovery process in Silver Bow Creek". They did not state that "The recovery of insect communities in the Upper Clark Fork River is 8-10 years further advanced than that in Silver Bow Creek".

The original report offered as evidence for improvement of the Clark Fork the gradually increasing densities and diversity indices since 1972. As noted above, comparison of diversity indices from pre-1979 studies (family level of identification) with later studies (species level) is incorrect. However, Figures 4-1, 4-2, and 4-3 compare number of taxa from 1975 through 1983 among those stations where data are available. All comparisons were based on family level identifications and reflect a consistent trend among years of more taxa at Clark Fork River stations than Silver Bow Creek stations. This finding is not speculative.

Third Paragraph, Second Bullet Comment:

o Diversity values at the various Clark Fork River stations are generally less than 3.0, and therefore indicate the continued existence of impacts and the need for further recovery.

Response: Diversity values at the Clark Fork River stations (G, H, I, K), as shown in Table 3-1 of the original report, from 1979 through 1984, were often less than 3.0. Values exceeded 3.0 during three years at station K, two years at station I, and during none of the years at stations G and H. In contrast, diversity values at the Mill-Willow Bypass station (F, the reference station) exceeded 3.0 five out of six years during the comparable 1979 through 1984 period. These data are not speculative and imply a different set of conditions more conducive to benthic community diversity in the Mill-Willow Bypass than at the downstream stations.

Third Opening Paragraph Third Bullet Comment:

- Further improvements in the aquatic insect community in the Upper Clark Fork River may be retarded by increasing metals concentration in the river below Warm Springs Ponds.

These conclusions are largely speculative and should be qualified with respect to the uncertainties and limitations in the data and the methods for judging impacts.

> Response: As correctly noted by the reviewers, this statement is speculative. It simply presents the idea that future improvements in the aquatic insect community "may" be retarded by increasing metals concentration.

Fourth Paragraph Comment:

The assumption that Shannon-Weiner diversity of unpolluted aquatic insect communities ranges from 2.6 to 4.0 is at best a generalization based on a wide range of aquatic habitats. The extent to which this generalization applies to site-specific conditions on the Clark Fork River is not known, and should be discussed in detail if it is going to be the basis for assessing impacts. Also, for the years 1980-1984, diversity values for the Clark Fork River stations ranged from 1.9 to 3.6 below Warm Springs Creek, from 2.8 to 3.2 at Deer Lodge, and from 2.8 to 3.5 below the mouth of the Little Blackfoot River. Average diversity values for the 1980-1984 period ranged from 2.7 to 3.1 for these three stations. Thus, based on diversity alone, it could be argued that impacts on the aquatic insect communities in the Clark Fork River are marginal, if they exist at all.

> Response: Wilhelm (1970) reported that most diversity indices determined for benthic communities in 22 unpolluted streams ranged between 3.0 and 4.0. As noted previously, diversity values at Clark Fork River stations have occasionally fallen into this range, but not on a consistent year-to-year basis. Authors of the original report

were simply stating that there is room for improvement at the Clark Fork River stations. This is best illustrated by diversity indices in the Mill-Willow Creek Bypass (control station) that ranged from 3.45 to 4.35 from 1980 through 1984. At Clark Fork River stations I, J, and K, diversity indices ranged from 1.9 to 3.6 during this same period.

Fifth Paragraph Comment:

For the years 1980-1984, abundances, numbers of taxa, and biomass in the Clark Fork River between Warm Springs Ponds and Deer Lodge overlapped considerably with those for the putative reference station on Mill-Willow Creek. Abundances, numbers of taxa, and biomass at the Clark Fork station below the Little Blackfoot River were considerably less than those at Mill-Willow Creek in 1980, but were within the range of values for Mill-Willow Creek in subsequent years. Thus, given the enormous interannual and spatial variability in benthic community data, it is likely that few, if any, differences between the Clark Fork River stations and the Mill-Willow Creek reference area would be significant in a valid scientific study.

Response: The reviewer's suggestion that "few, if any, differences between the Clark Fork River stations and the Mill-Willow Creek reference area would be significant" is speculative. During the 1980-1984 period, general trends were apparent for benthic invertebrate abundances and numbers of taxa proceeding from the reference station in the Mill-Willow Bypass to the downstream-most Clark Fork River station. The annual recurrence of these general patterns during the referenced five-year period was most likely due to something other than chance. AMC may implement an annual monitoring program under State order and appropriate State supervision at the same benthic stations as investigated in the past if it needs additional data to determine whether real differences exist among benthic communities within the project area.

Sixth Paragraph Comment:

The conclusion that benthic invertebrate recovery in the Clark Fork River may be retarded by trace metal concentrations is based on Phillips' (1985) hypothesis that decreasing trout abundances downstream from Warm Springs Ponds are associated with increasing trace metal concentrations. Given the wide range of variables that may affect trout distribution patterns and that need to be documented to assess trace metal toxicity, any extrapolation from existing hypothetical impacts on trout communities to retarded recovery of insect communities is extremely speculative and highly premature. The speculative nature of this extrapolation is particularly evident in light of the fact that depressed brown trout abundances occur in the reach between Flint Creek and Rock Creek, which is approximately 20 miles downstream from the benthic community study area (see comments on the Bioassay and Fish Tissue Investigations).

Response: The stretch of the Clark Fork River between Flint Creek and Rock Creek has the lowest trout population, but as far upstream as Deer Lodge the population appears to be depressed. There is no conclusive evidence that the depressed trout populations in the Clark Fork River are due to metals concentrations, but there is evidence that this is a possible contributing factor.

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: No response needed.

BIOASSAY INVESTIGATION
(APPENDIX E, PART 2)

OVERVIEW

The Silver Bow Creek Bioassay Investigation consists of a draft report published by the Environmental Services Division, of the U.S. EPA (Parrish and Rodriguez 1986). Three bioassays were conducted on eggs and fingerlings of the rainbow trout (Salmo gairdneri) over a 30-day period:

- o A 30-day test of green trout eggs designed to measure egg mortality
- o A 30-day test of eyed trout eggs designed to measure abnormal development, hatching success, and egg mortality
- o A 13-day test that measured mortality of fingerling trout.

Tests were conducted during a period of anticipated spring-runoff (7 May-6 June 1985) because it was hypothesized that trace metal concentrations are elevated during high flow conditions and may be toxic to rainbow trout. In general, the bioassay methods, test apparatus, and chemical analysis appear to be appropriate and follow U.S. EPA methods for toxicity testing.

GENERAL COMMENTS

First, Second, and Third Paragraph Comments:

Rainbow trout were selected for toxicity testing because they are absent from the upper reaches of the Clark Fork River above Rock Creek, and because in laboratory experiments they are more sensitive to copper toxicity than the resident brown trout (Salmon trutta) that inhabit the upper reaches of the Clark Fork River. Thus, the objectives of this study were to test the hypothesis that distribution of rainbow trout and brown trout in the Clark Fork River can be explained by trace metal toxicity.

However, it should also be recognized that there are a number of additional variables and alternative hypotheses that should be considered in evaluating the distributional aspects of rainbow trout and brown trout in the Clark Fork River. Clearly, four kinds of information are needed to test the toxicity hypothesis, as well as possible alternative explanations of trout distribution patterns that are not entirely dependent on the presumption of trace metal toxicity:

- o A detailed spatial and temporal characterization of the physical and chemical conditions in various reaches of the river where trout populations are apparently elevated, within the range of normal variability, and depressed

- o Concurrent ecological analyses of biological factors that may affect trout populations (e.g., habitat availability, trout community composition and abundances, and abundances of prey, predators, and competitors)

- o Concurrent analyses of toxic conditions using a variety of in situ and, possibly, laboratory Bioassay

- o Analysis of physical, chemical, ecological, and toxicological conditions in a comparable reference stream to establish background conditions, and define a range of natural variability for trout populations.

According to Parrish and Rodriguez (1986), "results of the flow-through bioassay tests were not conclusive." Presumably, this statement means that statistically significant effects were not observed for any of the test organisms or toxic endpoints measured. However, this assumption cannot be verified because quantitative methods used to analyze the toxicity data are not discussed. This information is needed to evaluate the report if it is to be used in the RI/FS. In the green-egg test, mortalities ranged from 4 to 11 percent, with the greatest mortality occurring in the control (i.e., 0 percent Clark Fork River water). In the eyed-egg test, a high proportion of the embryos hatched (98.5-100 percent)

with a low frequency of abnormalities (0.5-1.5 percent). Post-hatching mortalities ranged from 4.5 to 14.5 percent, with 5.5 percent in the control test. In the fingerling bioassay, mortalities ranged from 0 to 20 percent, with 7 percent in the control tests. Thus, in each of the bioassays the toxic response was generally low and within the range of control values for nontoxic conditions.

Concentrations of copper and zinc sporadically exceeded U.S. EPA Ambient Water Quality Criteria for acute and chronic toxicity during the last 15 days of testing. Peak concentrations of acid-soluble trace metals were associated with local rain events, overflow of Silver Bow Creek into Mill-Willow Bypass upstream from the Warm Springs Ponds and transient increases in river discharge rates. Consequently, Parrish and Rodriguez (1986) state that the elevated eyed-egg and fingerling mortalities in 100 percent Clark Fork River water in comparison with control water from Taylor Creek may be indicative of increased trace metal sensitivity, but that the duration of exposure to elevated trace metals concentrations, especially copper, was not "long enough to produce significant mortality." Data are also presented that show that the river discharge was much less than anticipated. Consequently, Parrish and Rodriguez (1986) hypothesize that "if normal spring runoff with its high metals concentrations had occurred as predicted, mortalities would probably have increased."

Response: In selecting rainbow trout (rather than brown trout) for toxicity testing it should also be noted, as pointed out on page 3 of the original report, that "Eyed rainbow trout eggs were to be used in the bioassay since the state did not have a source of brown trout eggs." There is no mention in the original report that rainbow trout were selected as a test species because they are more sensitive to copper toxicity than brown trout.

The object of the bioassay tests, as stated on page 3 of the original report, "was to determine the potential effects of metals (primarily copper and zinc) in the river water on trout eggs and larvae during various stages of development". The reviewer has presumed that study

objectives "were to test the hypothesis that distribution of rainbow trout and brown trout in the Clark Fork River can be explained by trace metal toxicity," to the total exclusion of other potential and plausible factors that may affect fish distribution and abundance which were listed on page 69 of the review document. This hypothesis was never stated in the original report and is much more ambitious than the study objective that was described above. It should be added, however, that trace metal toxicity can certainly be a potential contributing factor in fish distribution, abundance, and health.

Fourth Paragraph Third Sentence Comments:

These conclusions are largely interpretive and are based on suggestive data generated in experiments with negative results. However, negative experimental results can provide useful information. For example, the data indicate that significantly toxic conditions may not exist under low flow conditions when water quality criteria are exceeded sporadically during local rain events and transient increases in river discharge rates.

Response: This sentence is speculative. It presumes that sporadic exceedances of water quality criteria would not be of a magnitude that could potentially result in significant toxic conditions.

Fifth Paragraph Second Sentence Comment:

In summary, exposure of rainbow trout eggs and fingerlings to Clark Fork River water yielded negative experimental results, despite sporadically high concentrations of copper and zinc that exceeded water quality criteria.

However, the experimental design was partially confounded by unseasonably low flows in the Clark Fork River. Thus, the hypothesis that rainbow trout toxicity is associated with prolonged exposure to elevated trace metal concentrations under high flow conditions remains untested.

> Response: Toxicity effects under high flow conditions remain untested, as noted by the reviewer. Authors of the original report recommended "Repeating the bioassay tests during a normal high flow spring runoff . . . .".

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

> Response: No response needed.

FISH TISSUE INVESTIGATION
(APPENDIX E, PART 3)

OVERVIEW

First Paragraph Comments:

Tissue concentrations of various trace metal and organic contaminants associated with the Silver Bow Creek drainage were measured in rainbow trout (*Salmo gairdneri*) in the vicinity of the Warm Springs Ponds by MultiTech (1986). Arsenic, cadmium, copper, zinc, pentachlorophenol (PCP), and polychlorinatedbiphenyls (PCBs) were the contaminants investigated.

GENERAL COMMENTS

First Through Fifth Paragraph Comments:

According to MultiTech (1986), brown trout (*Salmo trutta*) were originally proposed for the assessment of contaminant bioaccumulation. Brown trout are the dominant salmonid in the upper reaches of the Clark Fork River, and have been studied with respect to trace metal bioaccumulation in past years (Dent 1975; Phillips 1982). Nevertheless, rainbow trout were selected for study after consultation with personnel from the Montana Department of Health and Environmental Services, and the Montana Department of Fish, Wildlife, and Parks. Further justification for species selection is not provided by MultiTech (1986).

Rainbow trout may have been selected for study because they are virtually absent from the upper reaches of the Clark Fork River, and because additional data characterizing contaminant bioaccumulation may provide

some insight regarding the effects that trace metal toxicity may have on their distribution. However, there are several limitations to the selection of rainbow trout for the bioaccumulation study. Tissue concentrations of contaminants in rainbow trout may not be spatially or temporally comparable with past studies that focuses on brown trout. Consequently, tissue concentrations of contaminants in rainbow trout may not be representative of human exposure to trace metals in edible flesh of brown trout. Therefore, brown trout should have been used in the investigation.

Ten rainbow trout were collected from the Wildlife Ponds that are located between the two upper Warm Springs settling ponds. Trout were collected between 7 July and 27 August 1985. Concentrations of arsenic, cadmium, copper, and zinc were measured in fillets and livers from five of the fish. Concentrations of PCP and PCBs were measured in fillets and gonadal tissues from the remaining five fish. According to MultiTech (1986), gonadal tissue was analyzed for organic contaminants because it has a high fat content and is presumably a favorable site for deposition of lipophilic substances. However, this justification does not make credible scientific sense because fish livers also have a high fat content, are a primary site for enzymatic detoxification and transport of organic contaminants, and are much better understood in terms of contaminant bioaccumulation. Presumably, the real issue associated with analyses of gonadal tissues is depressed rainbow trout populations in the Upper Clark Fork River. Therefore, information on organic contaminant concentrations in gonadal tissues may be useful in formulating hypotheses of reduced reproductive capacity in rainbow trout populations. If this is the case, MultiTech (1986) should indicate how the selection of species and tissues can be used to clearly define remedial alternatives at the site.

In addition to tissue analyses, monitoring information for trace metal concentrations in water at the fish collection site are summarized for the period of December 1984 through August 1985. Sample handling, analytical

methods, and QA/QC procedures for waterborne concentrations of the various contaminants are not described and cannot be evaluated. This information should be provided because the quality of data may affect the validity of data analyses and interpretation.

Results of the bioaccumulation study were then used in a variety of comparisons to determine the need for further studies of bioaccumulation and potential human exposure pathways. Each of these areas are briefly summarized below, and discussed with respect to the appropriateness, limitations, and uncertainties of the results and conclusions.

> Response: The study objective was to gather data on fish in the Warm Springs Ponds (either rainbow trout or brown trout - see page 1-6 of the original report) because "their easy accessibility and large size make them tempting to poachers" (see page 1-4 of the original report). Data were then to be used to determine the degree of risk that would be associated with ingesting the flesh of fish present in the Warm Springs Ponds. Studies had previously been conducted on metals concentrations in fish from the upper Clark Fork River; additional studies in the upper Clark Fork were therefore deemed unnecessary.
>
> Contrary to the reviewer's suggestions, the study objective was not to extrapolate data from the Warm Springs Ponds to the upper Clark Fork River or to develop a scenario based on Warm Springs Ponds data that would somehow explain the absence of rainbow trout from the upper Clark Fork (see reviewer's comments on pages 72 and 73). The study objective was simply to determine the degree of risk that would be associated with ingesting fish present in the Warm Springs Ponds. Much of the rationale suggested by the reviewer for why rainbow trout were selected for study does not appear to make "credible scientific sense", to borrow a phrase used by the reviewer in the first full paragraph on page 73.

After a rather extensive critique, the reviewer subsequently stated on page 77 that "MultiTech's (1986) analysis indicates minimal public health risks, if any, associated with ingestion of trout from Warm Springs Ponds. This conclusion is within reason". This was the intent of MultiTech's study - to gather data for use in determining whether or not contaminant concentrations in the edible tissues of fish from the Warm Springs Ponds posed a potential health risk if consumed by humans. This information would subsequently be used in the feasibility study and risk assessment to determine if ingestion of fish from the ponds would represent a public health risk.

MultiTech's discussion of contaminant concentrations in rainbow trout from the Warm Springs Ponds (MultiTech study) and in brown trout from the upper Clark Fork River (previous studies) provided an overview of the potential (or lack thereof) for public health risks that may result from ingesting fish from each of these systems. There was no suggestion that contaminant concentrations in fish from one of these two systems were somehow representative of fish from the other system.

MultiTech explained its rationale for analyzing metals in fish livers and pcp/pcbs in fish gonadal tissues, namely to assess the extent of contaminant migration into fish in the Warm Springs Ponds. The reviewer's suggestions that there were ulterior motives behind the analysis of these tissues is speculative.

All information on water quality sampling in the Warm Springs Ponds is provided in Appendix C "Warm Springs Ponds Investigation" of the RI report.

Sixth and Seventh Paragraph Comments:

Comparisons with Regional and National Background

MultiTech (1986) concluded that concentrations of arsenic, cadmium, copper, and zinc in edible tissues (i.e., fillets) of rainbow trout from Warm Springs Ponds were within the range of natural variability. Concentrations of trace metals in fillets were within the range of values reported for background areas in the U.S. (Lowe et al. 1985), and for the Clark Fork River and several tributaries to the Clark Fork River (i.e., Little Blackfoot River and Rock Creek).

Regional and U.S. Background concentration of PCP and PCBs were not discussed by MultiTech (1986). However, MultiTech (1986) indicated that tissue concentrations of PCP in rainbow trout from Warm Springs Ponds were at least 1 order of magnitude lower than those in fishes from Lake Ontario, or in fishes fed an experimental diet of PCP-contaminated food. MultiTech (1986) also indicated that concentrations of PCBs in rainbow trout from Warm Springs Ponds were within the range of values (i.e., 0.13-15 mg/kg) for fishes residing in "aquatic systems downstream from urban areas". MultiTech (1986) implies by this logic that tissue concentrations of PCBs in rainbow trout from Warm Springs Ponds are problematic, and that "actual sources and transport mechanisms for PCBs in the Silver Bow Creek/Upper Clark Fork River system are unknown". However, it should also be recognized that PCB contamination is ubiquitous in the U.S., and that fish-tissue concentrations of PCBs in presumably unpolluted areas may overlap considerably with those from polluted urbanized or industrialized environments. In summary, meaningful conclusions concerning levels of PCP and PCBs in comparison with background areas cannot be made from the available data.

Response: The original report did not imply, as asserted by the reviewer, that PCBs were measurably elevated in flesh of rainbow trout from the Warm Springs Ponds, but rather that concentrations were less than the federal food standard. This finding was stated in both the Executive Summary and Conclusions section of the original report.

The report also concluded that "since Warm Springs Ponds fish are only exposed to Silver Bow Creek water and local sediments, the source for this PCB contamination must be local".

Eighth Paragraph Comments:

Contaminant Distribution Among Tissues

Concentrations of arsenic, PCP, and PCBs in fillets were approximately the same as concentrations for these substances in livers. However, cadmium, copper, and zinc were more highly accumulated in livers than in fillets. On the average, the ratio of liver concentration to fillet concentration was 48:1 for cadmium, 516:1 for copper, and 9:1 for zinc. MultiTech (1986) phrases in this finding the sense that differential accumulation of trace metals among various tissues is a characteristic pattern of polluted areas (particularly for nonessential trace metals such as cadmium), and a noteworthy feature of trace metal bioaccumulation in Warm Springs Ponds trout. However, the high accumulation of cadmium, copper, and zinc in liver tissue in comparison with fillets is not an unusual feature, and is probably related to the role of the liver as a key site of metallothionein enzyme activity in fishes (Jenkins et al. 1982). Metallothionein functions in the regulation of essential trace metals such as copper and zinc, and in the detoxification of some nonessential trace metals such as cadmium.

Response: The reviewer again appears to be searching for some ulterior motive behind fish tissue investigations that does not exist. An extremely important finding of this study was that concentrations of arsenic, copper, and zinc in fish muscle were less than standards; over 6 pounds of fish muscle would have to be ingested per week to exceed standards associated with cadmium. This type of information is exactly what the study was designed to determine.

Ninth Paragraph Comments:

Bioconcentration Factors

MultiTech (1986) also estimated bioconcentration factors (BCFs) for the rainbow trout collected in the vicinity of the Warm Springs Ponds. The trace metal BCFs estimated for rainbow trout collected in the vicinity of Warm Springs Ponds were generally within the range of values (i.e., within 1 order of magnitude) reported by other investigators in laboratory and field studies. BCFs were not estimated for PCP and PCBs because concurrent water quality data were unavailable for these substances. The calculation of BCFs for trout from Warm Springs Ponds is of questionable usefulness for several reasons. BCFs are affected by numerous environmental and biological facts, and, therefore, are enormously variable. In the absence of site-specific information, BCFs are typically used to estimate tissue concentrations in an order-of-magnitude approximation of potential biological or human health impacts. Consequently, there seems little need to estimate BCFs from limited site-specific data because tissue concentrations were actually measured in rainbow trout from Warm Springs Ponds and were used in direct comparisons with comparable data from other studies.

Response: Bioconcentration factors (BCFs) can be easily calculated once data on contaminant concentrations in fish tissue and in the surrounding water are available, as they were in the Phase I RI.

BCFs provide a measure of whether contaminants are accumulated in various fish tissues at the same or different rates. They also provide a baseline for future comparisons to determine whether remedial actions directed at improving water quality have resulted in a commensurate reduction in the rate at which contaminants are accumulated in various fish tissues.

Tenth Paragraph Comments:

Target Organs and Differential Bioaccumulation of Contaminants

MultiTech (1986) also compares tissue concentrations of the various trace metals and organic contaminants with one another. The rank order of trace metal concentrations in the various tissues was:

- Fillets (cadmium < arsenic < copper < zinc)

- Livers (arsenic < cadmium < zinc < copper).

MultiTech (1986) emphasizes the relative differences among tissue concentrations of the various trace metals on several occasions in the Fish Tissue Investigation report, but offers little interpretation or discussion of the relevance of these findings. Differences among trace metal concentrations in various tissues are probably due to:

- Differences in the relative amounts of trace metals in the water (i.e., cadmium < arsenic < copper < zinc), which is presumably the primary exposure pathway for trout

- Substance-specific differences in transport, metabolism, and elimination of the various trace metals.

- Differences in retention of essential trace metals (i.e., copper and zinc) in comparison with nonessential trace metals (i.e., arsenic and cadmium).

In summary, the higher concentrations of copper and zinc in comparison to arsenic and cadmium are consistent with environmental concentrations of these substances, and physiological mechanisms for the transport and regulation of essential and nonessential trace metals. MultiTech (1986) should discuss whether the observed contaminant concentrations are within the tolerance range of resident fishes.

> Response: The reviewer's comments regarding "whether the observed contaminant concentrations are within the tolerance range of resident fishes" in the Warm Springs Ponds are appropriate. However, this investigation was not designed to gather information on whether the concentrations are harmful to fish, but whether eating the fish would be harmful to humans.

Eleventh Paragraph Comments:

Tissue concentrations of PCBs were approximately 1 order of magnitude greater than those of PCP. Differences between PCP and PCB concentrations in tissues could not be related to environmental concentrations of these substances because of a lack of site-specific information. Also, no interpretation of the results is provided with respect to the effects, if any, of the observed contaminant levels on resident fishes. Consequently, additional consideration should be given to the adequacy of the study design and results in a determination of whether any meaningful conclusions can be drawn from these data.

> Response: Again, the investigation performed was to determine if fish inhabiting the Warm Springs Ponds are safe to eat. With respect to PCP and PCB contamination, it is believed that this has been accomplished.

Regulatory Tolerances

MultiTech (1986) used several methods to evaluate potential health effects associated with ingestion of rainbow trout:

- o Comparisons with various regulatory standards that define upper limits of contaminant concentrations in various kinds of food

- o Comparisons with various regulatory tolerances that define upper limits for the amount of contaminants that may be ingested over a specified period of time.

MultiTech's (1986) analysis indicates minimal public health risks, if any, associated with ingestion of trout from Warm Springs Ponds. This conclusion is within reason.

Response: No response necessary.

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: No response needed.

(APPENDIX E, PART 4)

WATERFOWL INVESTIGATION

All Paragraphs

OVERVIEW

The purposes of the waterfowl investigation were to provide data to be used in an evaluation of human health risks associated with consuming waterfowl from the site and to be used to assess the migration of contaminants into the biota using the site. At the request of the Montana Department of Fish, Wildlife and Parks, specimens collected by the Montana Department of Fish, Wildlife and Parks were used in the analysis of tissue contaminant concentrations. Waterfowl were collected during 1984 from the Warm Springs Ponds, using shotguns with lead shot. Birds were collected during February, March, July, August, and September. A total of 41 specimens were collected from Warm Springs Ponds, representing at least nine species (some specimens were identified only to genus). A total of four specimens were collected from two "control areas" during December. Breast muscle tissues from 39 specimens were analyzed for arsenic, cadmium, copper, and zinc. Liver tissues from five Warm Springs Ponds specimens were analyzed for the same metals.

Waterfowl tissues were also analyzed for pentacholorophenol (PCP) and polychlorinated biphenyls (PCBs). Muscle tissues from four Warm Springs Ponds specimens and one control-area specimen were analyzed for PCP. Liver tissues from five Warm Springs Ponds specimens were analyzed for PCBs.

The concentrations of metals and organics determined in the analyses of Warm Springs Ponds waterfowl tissues were compared to regulatory standards, background levels developed from a literature review, U.S. Department of Agriculture (USDA) surveys of contaminant concentrations in domestic waterfowl, or tissue concentrations for waterfowl collected in the control areas.

Many conclusions reached by MultiTech are questionable, because of numerous problems with the study design, sampling procedures, methods of data analysis, and interpretation of data. The determination of human health risks is probably not adequate for the objectives of a Superfund investigation. MultiTech does not provide sufficient data to determine whether there is a significant threat to the biota using Warm Springs Ponds or the Superfund site as a whole.

GENERAL COMMENTS

Appropriateness of Study Design

The waterfowl investigation did not meet a number of basic criteria appropriate for any study designed to evaluate the importance of contaminant concentrations in free-living animals. The major problems with the study design are discussed briefly below.

There were several problems with the sampling design. First, the same species (or mixes of species) were not sampled in both control areas and Warm Springs Ponds to minimize the effects of uncontrolled differences in potential exposure or bioaccumulation resulting from ecological or physiological differences among species. The only waterfowl collected in the control areas were four adult Mallards, whereas both adult and juvenile birds of a variety of species were collected from Warm Springs Ponds. Second, sampling for spatial comparisons was not done at the same time of year in both Warm Springs Ponds and the control areas. Birds were collected from control areas in December, whereas birds were collected from Warm Springs Ponds in February, March, July, August, and September, but not in December. Because waterfowl are migratory, there may be uncontrolled effects of differences in exposure due to age or to population movements. Third, the sample of only four birds from the control area may not have been adequate for statistical tests with sufficient power to detect the magnitude of differences appropriate to the questions posed.

No justification is given for the choice of species samples as indicators of contaminant effects on the Superfund site, nor is an explanation given for why waterfowl should experience a high level of exposure to contaminants compared with other potential indicator species. Furthermore, MultiTech provides no data to indicate that the two designated control areas are appropriate, uncontaminated reference areas. The exact locations of the two control areas are not given. Without these supporting data, comparisons between Warm Springs Ponds and the control areas are of little value.

Additional constraints to those discussed above are imposed on the study design by the specific objectives of the waterfowl study. The two different objectives of the waterfowl investigation require different study designs. For an evaluation of health risks associated with the consumption of waterfowl, species should be selected for analysis on the basis of local consumption patterns and residency during the period of harvesting. For waterfowl, the period of harvesting corresponds to the fall hunting season. None of the Warm Springs Ponds specimens were collected during the hunting season (roughly October-January in many areas). Because waterfowl are migratory, it cannot be assumed that concentrations of contaminants in animals collected at other times of the year represent the concentrations of contaminants to which local human populations would be exposed.

It is not clear what is meant by MultiTech's second stated objective, "to assess the migration of contaminants into the biota utilizing the site". If the term site refers to the Silver Bow Creek Superfund site, as is indicated at the top of page 1-5, evaluating the concentrations of contaminants in the tissues of waterfowl using Warm Springs ponds may not be the best way of accomplishing the stated objective. Other study areas might be more representative of the Superfund site as a whole. Furthermore, an evaluation of the extent of exposure to local birds or mammals would best be based on studies of resident species with maximal potential for local exposure, not on migratory species known to forage widely.

The general problem with collecting migratory waterfowl to evaluate the potential for exposure of biota using Warm Springs Ponds is that it cannot be assumed that individuals have spent any appreciable time feeding on the potentially contaminated resources of the pond system. Data concerning the residence of birds using the ponds must be available to interpret the results of the chemical analyses. Such data were not presented by MultiTech. Even if the tissues of adults were found to contain high concentrations of contaminants, it cannot be concluded that the area where the birds were collected was the source of those contaminants.

The basis of MultiTech's choice of metals of concern is not clear. Many more contaminants are listed in Table I-1 on Page I-3 than were included in the analysis. Apparently, the determination of metals of concern was made primarily on the basis of the report by MultiTech and Stiller (1984), with the exception that lead analyses were not performed, because birds were collected with lead shot. It is not clear from the discussion and tables presented in Attachment I why certain possible metals of concern were not analyzed. Lead was determined to be a contaminant of concern, and its omission from the analysis limits the conclusions that can be drawn from the data.

Adequacy of Sampling and Analytical Procedures

Several problems exist with the sampling and analytical procedures reported. There is no indication that all samples were frozen immediately after collection, and it appears that all were not. This situation may not affect the validity of the metals analyses, but could seriously affect the analyses for organics (PCP and PCBs). Because holding times (between sample collection and analysis) were not given, it cannot be determined whether appropriate limits for holding times were exceeded, which could also affect the validity of the analyses. Apparently, neither chain-of-custody forms nor complete record-keeping systems were used to provide histories of sample handling. Because information on sample histories is lacking, the possibility that sample handling procedures may have violated QC standards must be considered.

Correctness of Data Analysis and Interpretation

Statistical Analyses--

The primary method of statistical data analysis was the use of independent t-tests for numerous comparisons of sample means. The use of multiple t-tests is only appropriate if the criterion significance levels are corrected for multiple comparisons (Sokal and Rohlf 1969). The correction is required because, when a large enough number of tests are conducted, it can be predicted that by chance alone some tests will indicate a significant differences, even when none exist. The correction lowers the criterion significance level for each test, so that larger differences are necessary to demonstrate significance. The failure of MultiTech to correct the criterion significance levels renders all conclusions regarding statistical significance questionable.

Concentration data were analyzed as raw values (mg/kg) and after transformation to square-roots or logarithms to produce normal distributions. MultiTech states that the transformed values were "preferred" for statistical analyses. However, no indication is given that distributions of the untransformed data violated the assumption of normality for the t-test, that the transformations that were performed actually produced normal distribution of data, or that the violation of normality would create a bias in the results.

MultiTech used regression analyses to evaluate the relationships among concentrations of the various metals analyzed. The same problem with multiple comparisons as discussed above may have occurred with these regression analyses.

Sample Sizes--

Samples for some of the comparisons were too small or otherwise inadequate. For example, the sample for comparisons of muscle and liver tissue was inadequate. The size of the liver tissue sample (five

specimens) was too small; it was composed of individuals of two species, creating a potential source of uncontrolled variability; it was not randomly selected from the pool of available samples; and it was composed of individuals collected at a time of the year (February and March) when migration was potentially ongoing. Similarly the control sample sizes of four specimens for metals analysis of muscle tissue and one specimen for organics analysis of muscle tissue were too small for meaningful statistical analysis. Because no control samples were analyzed for metals or organics analyses of liver tissue, there is no local reference for comparison.

Comparisons with Regulatory Standards

MultiTech reviews available regulatory standards for acceptable concentrations of arsenic, cadmium, copper, and zinc in food. Table 3-2 on page 3-4 lists various recommended standards promulgated by the USDA for meat inspections of cattle and swine, by the World Health Organization for weekly intake of metals, and by the Canadian Food Directorate (unspecified application). These standards are used for comparisons with the measured concentrations in waterfowl tissues to evaluate potential health risks. Because it is stated by MultiTech that the human health risks will be evaluated in the Feasibility Study using data collected in the waterfowl investigations, the health risk evaluation presented in the Waterfowl Investigation Report is not reviewed in detail here. MultiTech's intention to provide a more complete health evaluation in the Feasibility Study is appropriate. However, for reasons discussed above, the data may not be of sufficient quality for a public health evaluation.

Comparisons with Background Concentrations

Worldwide Studies of Contaminant Concentrations in Aquatic Birds--

Concentrations reported in other studies for arsenic, cadmium, copper, zinc, and PCBs in bird tissues are listed in Table III-1 through III-5

(pages III-1 through III-12). For the most part, these values are of limited usefulness as background reference concentrations for the Silver Bow Creek site. Many of the studies were conducted in areas known to be polluted. Most of the data are for marine birds, and few of the species studied were actually waterfowl (Anseriformes). MultiTech did not evaluate the applicability of the results of these studies as reference data.

USDA Studies of Duck Tissue--

In Table 3-3 on page 3-26, MultiTech also presents concentrations of arsenic, cadmium, and zinc in domestic ducks (tissue and locations of samples unspecified) compiled by the USDA. No specific reference is cited. Presumably these values are for muscle tissue. MultiTech also cites USDA data provided by Spaulding (1985), in a personal communication, for the "national average" and USDA "high" for metals concentrations in liver tissues of domestic waterfowl. Data on PCB concentrations in domestic ducks are cited from Spaulding (1986). MultiTech indicates that the ducks sampled were intended for human consumption.

Concentrations of cadmium in muscle tissues from eight Warm Springs specimens exceeded the upper value recorded for cadmium by USDA (0.15 ug/g wet weight). The fact that one control sample also exceeded this value suggests either that the control area may be relatively high. The fact that copper concentrations in Warm Springs Ponds waterfowl exceeded the USDA concentrations suggests that MultiTech's statement that cadmium was the only metal appearing in "elevated concentrations" needs to be qualified. There were no USDA values for zinc with which to compare.

Summary Comments

There were major problems with the overall study design, sampling procedures, methods and quality of the data analysis, and accuracy of the presentation in the Waterfowl Investigation Report. These problems are sufficient to qualify many of the conclusions reached concerning potential

contamination of the biota and the potential for human health problems resulting the consumption of waterfowl from Warm Springs Ponds. The analysis of potential exposure for biota on the site was deficient and incomplete. MultiTech presented no discussion of potential food chain effects, or, for that matter, any potential effects on animals resulting from bioaccumulation of metals or organic contaminants. There was also no discussion of how contaminants in Warm Springs Ponds waterfowl can be used to characterize conditions in other areas of the Superfund site or in other animal groups of interest. The statistical analysis of the data should be redone correctly. MultiTech needs to better describe, define, and evaluate the control areas and sources of data used to establish reference conditions.

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this appendix of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

> Response: The reviewer presents a good discussion of various factors that may affect the overall usefulness of waterfowl tissue data. Much of the discussion focuses on whether waterfowl collected at the Warm Springs Ponds were residents or migrants and, therefore, whether contaminants present in their tissues were derived from water, sediments, or flora/fauna present in the Warm Springs Ponds or from sources outside of the Silver Bow Creek study area. Data interpretation is further confounded by the collection of a variety of species during various months at the ponds as opposed to the collection of relatively few individuals at "control areas" during a different month of the year. Implementation of the original study design, which was outlined on pages 1-5 and 1-7 (Table 1-1) of the original report, would have served much better in meeting study objectives than the plan that was finally implemented (see Table 1-1 on page 1-7 of the original report).

Contrary to the reviewer's comments on page 80 (General Comments, Third Paragraph), there was a good basis for collecting waterfowl from the Warm Springs Ponds for tissue analysis. Authors of the original report commented that big game (deer, elk) and waterfowl (ducks, geese) are the two major groups of potential contaminant receptors and transporters (to humans through ingestion) in the area. Big game were not selected for study since their use of contaminated areas and, therefore, the number of animals potentially affected would be limited. Waterfowl use the Warm Springs Ponds throughout the year. Previous studies indicated significant quantities of contaminants are present in the bottom sediments and water of the Warm Springs Ponds. These contaminants could potentially be ingested by waterfowl at the ponds, which could in turn be ingested by waterfowl hunters. The ponds are reported to be a popular spot for waterfowl hunters.

The reviewer notes that "Because information on sample histories is lacking, the possibility that sample handling procedures may have violated QC standards must be considered". MultiTech addressed this subject in its report, stating that except for the use of lead shot which invalidated planned lead analysis, other deviations from the sample collection program had no direct effect on the data produced.

The reviewer raises several issues regarding the appropriateness of the statistical analyses. AMC should review the raw data and, if they deem necessary, conduct additional statistical analyses.

Despite the limitations discussed by the reviewer and alluded to above, data on waterfowl collected at the Warm Springs Ponds may provide a broad framework from which potential risks to humans via ingestion can be estimated. Warm Springs Ponds waterfowl were collected during February, March, July, August, and September. These specimens may have been largely residents, as opposed to migrants that pass through the area primarily during the hunting season

(roughly October through January) (and again during the spring). Contaminant concentrations in waterfowl collected during the study may therefore reflect the effects of inhabiting the Warm Springs Ponds area. If these same specimens had been collected during the hunting season, their contaminant concentrations may potentially have been encompassed by the range of values measured during February, March, July, August, and September. Contaminant concentrations during these months may therefore provide an approximation of contaminants in resident waterfowl that could be harvested at the Warm Springs ponds during the hunting season, and subsequently ingested by humans.

SUMMARY REPORT

OVERVIEW

In the Summary Report, MultiTech (1987c) consolidates many of the results and conclusions for the various studies conducted in support of the Silver Bow Creek Remedial Investigation. The Summary Report consists of an Executive Summary, an Introduction (Chapter 1), a Hazardous Substances Inventory (Chapter 2), and sections that synthesize information from each of the appendix reports (Chapters 3-8). Comments on the Executive Summary are combined with those for each of the pertinent chapters covered in the Executive Summary section. Otherwise, comments in this review follow the sequence of chapter headings as they appear in the Summary Report.

CHAPTER 1.0 INTRODUCTION

GENERAL COMMENTS

The introductory chapter summarizes or reiterates much of the information presented in the subsequent chapters of the summary report or in the appendix reports for the various studies conducted in support of the Silver Bow Creek remedial investigation. General comments concerning these studies are provided in the appropriate sections of this review.

SPECIFIC COMMENTS

1. Page 1-6, Line 11: The sentence states that the Anaconda Smelter CERCLA site "... is a major air emissions". This statement should be referenced or the basis for it should be provided.

   Response: Substitute "was" for "is".

2. Page 1-14, Line 22: Define and quantify "significant".

   Response: The total population of the small communities identified in the text is approximately 1400 persons.

3. Page 1-16, Line 20: The text states that the oxidation of sulfide minerals increases the solubility of many metals. Solubility is among other factors, dependent on pH. Solubility of some metals decreases with decreasing pH.

Response: Metals (and metalloids) of primary concern from a health and environmental perspective include As, Cd, Cu, Mn, Pb and Zn. Of these, Cd, Cu, Zn, and Mn solubility are strongly affected by pH. Their solubility increases with decreasing pH. Zinc and Al solubility can also increase at high pH values due to their amphoteric nature (they form soluble Zn(OH)3- and Al(OH)4-). We found Pb to be less strongly affected by pH, perhaps due to the low solubility of PbSO4 which is not pH-dependent. Arsenic solubility decreases at low pH; however, arsenic mobility is more strongly affected by redox potential than pH.

4. Page 1-16, Line 21: The sentence implies that any accumulation of bio-available heavy metals severely limits vegetation establishment. Some plant species become tolerant of heavy metals at different concentrations.

Response: The statement should be qualified to state that "Excessive accumulation of bio-available heavy metals severely limits vegetation establishment. The concentration which is "excessive" varies greatly from species to species".

5. Page 1-55, Line 19: The significance of the environmental impact on Summit Valley is unclear. Provide a description of the impact and define its significance.

Response: The point of this statement is to illustrate that mining and urban development contributed to increased erosion and sediment loading of Silver Bow Creek.

CHAPTER 2.0 HAZARDOUS SUBSTANCES INVENTORY

GENERAL COMMENTS

The hazardous substances inventory provides an overview of contaminants of concern in various environmental matrices, chemical and toxicological characteristics of contaminants, and environmental transport and fate of chemicals of concern. Much of the information is factual and is based on widely available references or agency documents. However, some of the information is derived from the various site-specific investigations. Consequently, general comments concerning these site-specific studies are provided in the appropriate sections of this review.

Response: No response necessary.

Specific Comments:

1. Page 2-1, Line 13: Other "waste types" are also possible, such as natural mineralization.

   Response: Evaluations as to the significance of natural mineralization as a "waste type" will be considered prior to completing feasibility studies in the study area.

2. Page 2-5, Line 6: The RI is supposed to produce data to define and delineate sources of contamination (i.e., tailings). Why are further studies needed?

   Response: Further studies are necessary because tailing volume estimates for the Parrot Tailings and Butte Reduction Works are based on one and three boreholes, respectively. Accurate appraisals of tailing volumes are necessary at both of these sites to evaluate several potential remedial alternatives (e.g. removal, isolation).

3. Page 2-7, Line 14: The RI is supposed to produce data to determine the locations of sources of contamination (see Page 1-2). Why are further studies required?

<u>Response</u>: Mine waste rock dumps located within and adjacent to the City of Butte were not evaluated during the Silver Bow Creek CERCLA Phase I RI because these areas are outside the study area associated with the investigation. These potential sources of contamination to storm-water runoff are being evaluated by other investigators of the Butte Hill.

4. Page 2-8, Lines 2 and 10: The RI should produce data to delineate contaminant sources. Why are more studies needed?

<u>Response</u>: See response to Comment 3.

5. Page 2-9, Line 4: A reference is needed for contaminant concentrations of natural lake bed sediments.

<u>Response</u>: Please see response to Comment 45 on Appendix C.

6. Page 2-9, Line 14: Is there a reason not to believe that the 19 million yd^3 is not an accurate quantity? If not, why perform another investigation?

<u>Response</u>: Hydrometrics (1983b) based its estimate of pond bottom sediment volumes on limited data. More accurate appraisal of pond bottom sediment volumes is necessary to address several potential remedial alternatives during the feasibility study (e.g. removal, encapsulation, isolation, no action).

7. Page 2-9, Line 19: The RI is supposed to produce data to determine the locations of sources of contamination (see Page 1-2). Why are further studies required?

Response: The reference to page and line number associated with this comment is not consistent with the comment. Our response is withheld pending clarification of the comment.

8. Page 2-11: Are the values mentioned in the second sentence of the third paragraph average concentrations? The text should explain what the values represent.

   Response: Concentrations are average values, as reported by the U.S. EPA in the cited reference.

CHAPTER 3.0 SURFACE WATER INVESTIGATION

GENERAL COMMENTS

First Paragraph Comments

In the Executive Summary (p. ES-5), MultiTech (1987c) discusses three surface water contaminant sources that were not investigated during the RI: Montana Post and Pole, Ranchland Packing Company, and Stauffer Chemical Company. Why were these point sources excluded and what is the basis for determining that they are "lesser point sources"?

Response: The discharge identified from the Montana Post and Pole was not observed flowing during the RI Study period, although an oil sheen was observed in Silver Bow Creek on numerous occasions. The discharge from the Ranchland Packing Company was observed discharging into Silver Bow Creek on two occasions, but the volume was 1 gallon per minute, and no metals analysis was performed on samples from this source. The discharge from Stauffer Chemical was sampled and the analysis, as presented on page A-7 of this document, shows that the metals concentrations are lower than those in Silver Bow Creek. The amount of flow from the Stauffer site was also very small, approximately 0.5 cubic foot per second average flow.

Second Paragraph Comment

Chapter 3 summarizes the information provided in the Surface-Water and Point-Source Investigation Report (Appendix A, Parts 1 and 2; MultiTech 1987) without providing any new information or analysis. Therefore, the comments provided for Appendix A also apply to the summary. The following is a brief review of the comments provided for Appendix A that affect the conclusions presented in the RI Summary Report on the surface water investigation.

Response: No response necessary.

Third Paragraph Comment

The source evaluation focused on quantifying loadings from individual sources and ranking the sources based on the loadings measured during the RI. However, the relative effect of the loadings from the various sources on water quality in Silver Bow Creek was not taken into account in the source ranking system. Although MultiTech specifically states on page 3-8 that the relative impact of each source on water quality in Silver Bow Creek is an important factor in developing remedial options, this aspect of the evaluation was not addressed in the analysis. Table ES-1 does provide some improvement over the source ranking developed in Appendix A and presented in Table 3-4 of the RI Summary Report, because separate rankings were determined for high flow and low flow conditions. The existing data indicate that source loading and transport processes in silver Bow Creek are highly variable and strongly influenced by flow conditions. The original ranking presented in Appendix A, which was based on the total load measured during the entire RI, was unacceptable.

Response: There are many different ways in which the surface water data collected during the RI can be evaluated. During the feasibility study, these data will be used to evaluate different alternatives. Different rankings of the sources will be created depending on the ARARS that are being considered.

Fourth Paragraph Comments

Insufficient data are provided to support the discussion presented in the RI Summary Report of transport mechanisms in Silver Bow Creek. A description of spatial and temporal trends in water quality and metals loadings in Silver Bow Creek, possibly using river profile plots, would help to substantiate these conclusions. In addition, in some cases, the information that is provided (average high-flow and low-flow loading values for Silver Bow Creek sampling stations; see Table 3-27 in Appendix A) contradicts the discussion of transport mechanisms in the text. For example, the data do not support the conclusion that deposition of solid-phase copper occurs under low-flow conditions between Station SS-07 and SS-08. Similarly, the data do not indicate that deposits of solid-phase zinc is a controlling factor in the reach between Station SS-04 and SS-07 under low flow conditions as shown in Table 3-4 of Appendix A.

> Response: Below Rocker, copper was transported in the solid phase more than the dissolved phase. These data are available in Appendix A, Part 2. Different analytical techniques may be used in the future to more closely pinpoint sources and sinks of contaminants during different flow regimes.

Fifth Paragraph Comments

Independent analysis of copper and zinc solubility performed by Tetra Tech using MINTEQ (Felmy et al. 1983) produced different results than those described in the RI Summary Report. The MINTEQ results indicate that copper precipitation is not likely to occur in Silver Bow Creek, but that zinc precipitation as zinc silicate may occur. Because an understanding of metals transport processes in Silver Bow Creek is essential to evaluate remedial alternatives, the RI report should thoroughly document all analyses used to determine transport processes in the river.

Response: Data collected during the RI (Appendix A, Part 2), show that dissolved copper concentrations decrease after Colorado Tails, with no additional water being added. In this same reach total copper stays approximately equal. This suggests of precipitation of copper. Dissolved zinc concentration in the winter time, when pHs were between 7 and 8, stayed consistent throughout Silver Bow Creek. In the summer time, with pHs near 10 in the lower reaches of Silver Bow Creek, dissolved zinc concentrations decreased, indicating precipitation.

Sixth Paragraph Comments

The frequency of exceedances of water quality criteria at each station on Silver Bow Creek during the RI is summarized in Table 2-4. This analysis provides an indication of the extent of the metals problem in Silver Bow Creek. However, additional information, particularly the magnitude of the exceedance of water quality criteria at each station is needed to determine the severity of the problem. This information would also be useful in developing a source ranking system by providing an indication of the relative impact of each source on water quality in Silver Bow Creek.

Response: The exceedances of various criteria (e.g. aquatic, human health) will be calculated during the public health and environmental assessment for the Silver Bow Creek site. Data used to generate Table 2-4 are contained in Appendix A (Surface Water and Point Source Investigations). Additional high flow and storm event data are presently available for Silver Bow Creek and the upper Clark Fork River from the supplemental RI (CH2M HILL 1987). These data will be reviewed and compared with the high flow data from this report to determine whether the metals loading and transport processes observed during the 1985 season are similar to the conditions observed during the 1986 season. Evaluation of data collected after the Phase I RI will be discussed in the final FS report.

Seventh Paragraph Comments

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section.

Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: No response necessary.

CHAPTER 4.0 HYDROGEOLOGIC INVESTIGATION

GENERAL COMMENTS

First Paragraph Comments

In the RI Summary Report, MultiTech lists eight objectives of the Phase I field hydrogeologic investigation. The RI Summary Report provides no specific description of the results of each objective. Five of the objectives indicate that quantification will be provided for various segments of the geohydrologic system and for its relationship with the surface water system. Many of the phenomena related to aspects of the stated objectives are not adequately quantified in Chapter 4. Specifically, the report does not provide a temporal or spatial baseline for water chemistry of "natural" groundwater. Groundwater discharges to surface streams are not quantified using geohydrologic data, although contaminant loadings that are based on groundwater discharge are provided in the RI Summary Report. No quantification of vertical fluid movement through the unsaturated zone of tailings is provided, except for Ramsay Flats, and thus the characteristics of any contamination in the vadose zone is not known.

Response: Appendix B of the Phase I RI details results associated with each study objective presented. We do not believe it consistent with the intent of a summary document to quantify various stated objectives. Rather, the summary document is prepared to familiarize the casual reader with general conclusions regarding site investigations. Specific details and exhaustive presentations in the Summary Report are intentionally omitted for this reason.

Second Paragraph Comments

It is presumed that a summary of a study would condense the findings of an investigation and discuss those findings in terms of the specific objectives and purposes of the study. Chapter 4 provides no such condensation. The subsections under Investigation Findings (i.e., Sources, Transport, Fate, and Severity and Extent of Contamination) provide very little quantification of study results and are primarily written in qualitative terms.

Response: Please see response to comment above.

Third Paragraph Comments:

In summary, this chapter of the RI summary Report does provide an accurate summation of the results of the various geohydrologic studies conducted during the SBC RI and extends the estimates of contaminant loadings from groundwater by using geohydrologic data. However, the chapter fails to adequately address the original objectives of the Phase I groundwater investigation. Perhaps the plan is to fill these gaps in the Phase II investigation, but this is not indicated in the text.

Response: Please see response to comment above.

Specific Comments

1. Page 4-1, Line 10; Were these objectives met? If so, what are the conclusions?

   Response: We believe the stated objectives were met. Conclusions regarding stated objectives are presented in Section 4.3 of the Summary Report and in Appendix B of the RI.

2. Page 4-7, Line 3: Natural mineralization is a source that was not considered. A reason for this omission is necessary or it should be included.

   Response: Direct evaluations of natural mineralization as a contaminant source to groundwater were not completed during the Phase I RI. This level of analysis will be completed during future remedial investigations at the operable units associated with the site.

3. Page 4-11, Line 3: "Highly" is a relative term. The author should define what is meant or leave the word out of the sentence.

   Response: The intent of the sentence is to indicate that, given stated conditions in the vadose zone, water released by bank storage mechanisms may contain elevated concentrations of metals with respect to MCLs or to upgradient groundwater wells.

4. Page 4-11, Line 7: "Driving the contaminants to depth" is not necessary. How deep are the contaminants driven?

   Response: The intent of the sentence is to indicate that discharges from the Weed Concentrator may cause a downward vertical gradient which would move contaminants from shallow sources to deeper zones in the area's groundwater system.

5. Page 4-11, Line 9: The significance of this potential natural source of contamination should be investigated under the objectives of the RI.

Response: We do not believe the postulated fault in the vicinity of Montana Street is a source of contamination. The presence of the feature would serve only to affect pathways of contaminant movement.

6. Page 4-11, Line 14 and Table 4-2: What are the bases for determining these loadings? Based upon average concentrations in wells located near the Metro Storm Drain or Silver Bow Creek and groundwater flow velocities determined from hydraulic data and aquifer test data, the following alternative loadings (lb/day) were calculated for copper and zinc:

Metal	MSD	Montana Street to Colorado Tailings	Colorado Tailings
Cu	2.5	5.7	36.0
Zn	4.0	23.8	110.7

Response: The bases are presented in the Groundwater and Tailings Investigation (Appendix B). Basically, surface water gains were used to derive the loadings. The alternate method proposed is also valid. However, it relies heavily on aquifer test data which are inconclusive and which have a very large range of hydraulic conductivities. The former method (surface water gains) uses observed gains in stream flow and concentrations to "back out" groundwater loadings. In the absence of an additional, very large source of contaminants to SBC, groundwater inflow is the obvious source.

We are unable to further respond to numbers you present without reviewing data and methodologies used in your calculations.

7. Page 4-13, Line 16: While it is true that drinking water standards were exceeded for most parameters at several wells, in many cases

this exceedance was for only one sample for some constituents. Analysis of other samples indicate concentrations one or two orders of magnitude smaller than the maximum value at some wells. This wide variance in concentrations implies that the hydrochemistry varies greatly in time as well as space. It is not as the statement seems to imply that the wells contain water unfit for drinking water on a year-round basis. For some wells this is true. The temporal non-homogeneity of the data should be considered in the text.

Response: Relationships between drinking water exceedances and temporal trends are not presented nor does the statement in the text imply this relationship. Concentrations of parameters measured are related to exceedances of an established standard, a common method of comparative analysis.

8. Page 4-14, Line 4: What level of accuracy can be associated with the definition of the extent of groundwater contamination? This value will be necessary for design of the remedial alternatives, a purpose for data from the RI.

   Response: As stated in the text, exact boundaries of degraded groundwater were not discerned during the Phase I RI. To place an accuracy value on definition of the extent of groundwater contamination in the study area given available data, would be subjective, at best. Hence, we cannot provide a quantitative response to your comment. The need to better define groundwater contamination boundaries will be evaluated during future remedial investigations at the site.

9. Page 4-14, Line 11. On Page 4-11, Line 8, it is noted that a postulated fault may be causing contaminated groundwater to surface in the area. Such a fault would most probably extend into the bedrock. In that this fault is a possible pathway, why was it not included in the study and why was the bedrock that could be the contaminated source not investigated?

Response: We do not believe the postulated fault in the vicinity of Montana Street is a pathway of contaminant movement. We believe the fault may affect pathways of contaminant movement. The fault and bedrock system underlying the alluvial system in the Metro Storm Drain area were not specifically investigated during the RI because of budget limitations. The significance of the postulated fault in the vicinity of Montana Street in affecting pathways of contaminant movement will be evaluated during future remedial investigations of this area.

CHAPTER 5.0 WARM SPRINGS PONDS INVESTIGATION

General Comments

Most of the contents of Chapter 5 are extracted directly from the Warm Springs Ponds Investigation Report (Appendix C) of the RI. The comments made on that investigation are applicable to this chapter.

Chapter 5 provides a good discussion of the results of two of the objectives of the investigation. It is suggested that a reference to Chapter 2.0 be made in Section 5.3.2 concerning quantification of removal percentages for various constituents. More discussion of the results of the interrelationships of surface and groundwater studies should be provided. Were temporal trends identified in data on the potentiometric surface? Did changes in the water level of streams coincide with changes in the groundwater system? Did these changes affect contaminant flow paths? A summary of spatial and temporal variations in surface water quality and quantity should be provided or referenced to allow for more complete analysis of the surface water system.

Response: We agree with your suggestion of referencing Chapter 2.0 concerning quantification of removal percentages for various constituents. Data were lacking during the Phase I RI to adequately characterize interrelationships between surface water and groundwater

and temporal groundwater level trends in the Warm Springs Ponds area. These data are currently being collected at the site as part of Phase II RI activities.

Spatial and temporal variations in surface water quality and quantity are contained in Appendix C of the Phase I RI report.

Specific Comments

1. Page 5-8, Line 22: Define and quantify "significant."

   Response: The intent of the sentence is to indicate groundwater inflow has a measurable impact on water quality in the Mill-Willow Bypass.

2. Page 5-9, Line 3: Define and quantify "significant."

   Response: RI data on the the Mill-Willow Bypass presented in Appendix C, Part 1 (Table 3-19) show a 17.3% increase in flow along the Mill-Willow Bypass between SS-18 and SS-25, with a corresponding 74% to 310% increase in loading of six metals (Cu, Zn, Fe, As, Pb, Cd) and sulfate. Specific conductance survey data contained in Attachment IX indicate that this increase in flow and loading is due to seepage from both the east (Warm Springs Ponds) and west (Opportunity Ponds) sides of the Mill-Willow Bypass. This increase in loading is considered significant. The exact percentage of this increased loading from potential sources cannot be determined from the available data.

3. Page 5-10, Line 12: Define and quantify "significant."

   Response: This comment is addressed in the response to Comment 49 on Appendix C of the Phase I RI report.

4. Page 5-13, Line 21: A pH of 6.8-8.0 is not "low."

   Response: These values are low relative to pH values measured during the summer (pH ranging from 9.0-10.0).

5. Page 5-15, Line 19: Can the source of this contamination be determined? Elevated fluoride concentrations are noted upgradient of the ponds at WSP-1.

   Response: Please see response to Comment 48 on Appendix C of the Phase I RI report.

6. Page 5-16, Line 8: The sources of groundwater contamination have also not been thoroughly examined (i.e., natural sources upgradient of ponds).

   Response: Sources of groundwater contamination are being further characterized during the Phase II RI at the Warm Springs Ponds.

7. Page 5-16, Line 26: Provision for examining additional sources of contamination (e.g., hot springs, industrial facilities) should be made.

   Response: These types of sources are being evaluated during the Phase II RI at the Warm Springs Ponds.

CHAPTER 6.0 FLORA INVESTIGATIONS (ALGAE)

General Comments

In Section ES-3.3.1 of the Executive Summary to the RI Summary Report, MultiTech states that "phytoplankton residing in the Warm Springs Pond system concentrated certain metals from the water during spring 1985", and that the particular taxa included species of green algae (6 general), blue-green algae (*Oscillatoria* sp.), a diatom (*Synedra ulna*), and euglenids (Euglena sp.). MultiTech concludes that "a portion of the

bioaccumulator algal biomass appears to remain in Pond 2 with the remainder transported to the upper Clark Fork River". These conclusions are overstated and are not directly substantiated by the information provided in the Algal Investigation Report (Appendix D, Part 1, of the RI Summary Report).

The nine "particular taxa" identified by MultiTech were derived by cross-indexing two independent lists:

- o A list of algal taxa that have been shown in various field and laboratory studies to bioaccumulate trace metals (Table 3-2 in Appendix D, Part 1, of the RI Summary Report)

- o A list of algal taxa that were identified in Warm Springs Ponds 1, 2, and 3 during October 1984, and March-May 1985 (Table 3-3 in Appendix D, Part 1, of the RI Summary Report).

Note that many of the "particular taxa" discussed by MultiTech are typically found in the periphyton community (e.g., Cladophora) but were not among the dominant genera (i.e., Fragilaria, Chlorella, Chlamydomonas, and Pediastrum) that were identified during the phytoplankton study (Table 3-4 in Appendix D, Part 1, of the RI Summary Report).

It should also be recognized that trace metal concentrations were not actually measured in phytoplankton from Warm Springs Ponds in 1985. MultiTech's statements regarding trace-metal bioaccumulation and transport can be made about virtually any aquatic system. Bioaccumulation of trace metals is a fundamental biological process that occurs in most, if not all, aquatic organisms, and that is widely recognized in the scientific community. Because measurable quantities of trace metals have been observed in water from Warm Springs Ponds, it is reasonable and logical to assume that trace metal bioaccumulation occurs in phytoplankton from Warm Springs Ponds. Phytoplankton are, by definition, highly transitory and transported by water currents and it is reasonable to expect that a

proportion of the phytoplankton community from Warm Springs Ponds is transported downstream to the upper Clark Fork River. However, key questions regarding the extent of bioaccumulation, loading to the river, and transport of trace metals in algal communities remain unanswered. In summary, MultiTech has demonstrated the existence of some fundamental processes that could be deduced equally well from reading a good textbook. However, the data are insufficient to determine whether the process of trace metal bioaccumulation and phytoplankton transport represent a quantitatively meaningful pathway in the Warm Springs Ponds system.

MultiTech also states that "previously published data (Shambaugh 1983) indicated that algae in the Warm Springs Ponds have higher concentrations of metals than water samples collected from the ponds". Shambaugh's (1983) study, which was not discussed in the Algal Investigation Report, is a student report prepared for a botany class at the University of Montana. Inspection of Shambaugh's (1983) data indicates that various species of aquatic vascular plants (e.g., duckweed) and aquatic fauna were collected and analyzed for trace metals concentrations. Algae were not sampled during the study. However, Shambaugh (1983) discusses preliminary findings of de Reuiter's (1983) study of bioaccumulation of trace metals by periphyton, which were presented in the Algal Investigation Report. Both Shambaugh (1983) and de Ruiter (1983) indicate that trace metals concentrations in biota collected from Warm Springs Ponds were determined on a dry weight basis. Bioconcentration factors and contaminant bioaccumulation are typically assessed on a wet weight basis. Consequently, even qualitative conclusions comparing trace metal concentrations in biota that are based on dry weight with concentrations in water are unlikely to be meaningful.

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: Comments on these pages are generally similar to AMC's comments on Appendix D, Part 1. Responses to these comments are contained in Appendix D, Part 1 responses.

The reviewer's comments regarding Shambaugh's 1983 study appear to be accurate. Comparing values for periphyton samples, which could conceivably have contained remaining sediment material, on a dry-weight basis with values for water samples likely overestimates bioconcentration factors. Examination of the raw data by AMC and comparison of contaminant concentrations in periphyton on a wet-weight basis (where such expression is possible) to water sample values may be more meaningful.

CHAPTER 6.1 - FLORA INVESTIGATION (RIPARIAN VEGETATION)

GENERAL COMMENTS

As stated on pages 6-4 and 6-5 of the RI summary report, the purposes of the riparian vegetation investigation were to document the location and geographical extent of tailings deposits and to map the riparian vegetation. As indicated on pages 6-4 and 6-5, the prospective uses of these maps and associated data apparently include identifying areas where remedial actions may be required ("operable units and potential corrective action sites"), characterizing contaminant sources, and identifying potential borrow areas (presumably for material to cover exposed tailings). Aerial photographs were used to map riparian vegetation and tailings deposits, using 14 categories of cover types (mapping units). Mapping units were verified in the field.

Detailed comments on the Riparian Vegetation investigation report are presented in the comments on Appendix D, Part 2. The major issues were as follows:

- MultiTech provides no discussion of the possible existence of critical habitats or threatened and endangered plant species in riparian areas

- Explanations for how mapping units were distinguished on the aerial photographs and how these were verified in the field were not sufficiently detailed to allow the accuracy of the maps produced to be evaluated

- MultiTech's statement on page 6-5 that previous studies have "adequately documented those riparian species that are tolerant of contaminated conditions" is not supported by the discussions in the reports cited in Appendix D, Part 2

- Although MultiTech indicates that reclamation planning is a major intended use for the results of the riparian vegetation investigation, no review of past reclamation work, if any has been done, is included in either the RI Summary Report or in Appendix D, Part 2

- There is no discussion of the need for reclamation or the potential for successful reclamation using approaches involving revegetation, such as those discussed by Hydrometrics (1983a,b,c).

<u>Specific Comments</u>

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section.

<u>Response</u>: This section summarizes AMC's comments on Appendix D, Part 2 of the Phase I RI report. Responses to these comments are contained in Appendix D, Part 2 responses.

CHAPTER 6.2 FLORA INVESTIGATIONS (AGRICULTURE)

GENERAL COMMENTS

First Paragraph Comments:

The objective of the agriculture investigation was to evaluate the extent of contamination of agricultural lands receiving irrigation waters from Silver Bow Creek or from the Upper Clark Fork River. Of the 16 stations where soils samples were collected, only five were documented in the report as being on irrigated lands. Three additional stations are downgradient of irrigation ditches, but it is unclear if they had historically received irrigation water from the irrigation ditches. Of the remaining stations, three were located upgradient of irrigation ditches, two were in the floodplain of Silver Bow Creek or the Upper Clark Fork River with tailings reported in the soil profile, and three stations were from sites with no evidence in the report of irrigation.

Response: The primary contention of the general comments section is that not all sites sampled on agricultural land are in upland landscape positions where irrigation water was the source of contaminants. Some of the sites are located in floodplain areas.

Substantial clarification of the study results would result by improving the statement of objectives for the Agricultural Lands Investigation. The soil sampling plan was designed with two primary objectives in mind:

1) Was irrigation water a historical source of contamination of agricultural lands located above the floodplain (in upland positions)?

2) What was the severity of contamination on agricultural lands (both floodplain and upland), as judged by soil and plant tissue metal levels?

It was the consensus of the project team that only after determining: 1) that the severity of contamination could threaten human health or the environment; and, 2) that the source of the contaminants was from mining activity in the headwaters of Silver Bow Creek, would it be appropriate to formally identify the extent of contamination of agricultural lands. Although some preliminary estimates of the extent of contamination are made through examination of historic and current aerial photos of the region, these estimates are not rigorously supportable. Hence, it is agreed that these estimates of the extent of contamination should have been reserved for later phases of the RI investigation.

It is also agreed that soil and plant tissue metals data from floodplain areas should have only been used to address the second objective. Samples collected from upland areas were generally paired in "upgradient" and "downgradient" positions relative to historical irrigation ditches. These data pairs are useful in addressing the first objective.

Hence, of sixteen sites sampled, there were six sets of paired samples in upgradient/downgradient positions which are valid for use in assessing the relative contribution of irrigation ditches as a source of contamination of upland surfaces.

The relative landscape position of all sites sampled is shown below.

SITE	LANDOWNER	LANDSCAPE* POSITION	UPGRADIENT/ DOWNGRADIENT
A10	Thurmonds	U	----
A11	Thurmonds	F	----
A1	Konda	U	up
A2	Konda	U	down
A3	Konda	F	----
T12	Peterson	U	up
T13	Peterson	U	down
T14	Peterson	U	up
T15	Peterson	U	down
T17	Peterson	U	up
T16	Peterson	U	down
A6	Spangler	U	up
A7	Spangler	U	down
A12	Foresons	U	up
A13	Foresons	U	down
A9	Dutton	F	----

*U - Upland, historically irrigated
F - Floodplain Area

GENERAL COMMENTS

Second Paragraph, First Sentence Comment

The agriculture investigation provides an analysis of the soil intermetal and soil metal-plant correlation that is irrelevant to the objective of the RI.

> Response: Although soil intermetal and soil metal-plant correlations are not explicitly stated as an objective of the RI, the information may be useful in developing remedial alternatives.

Second Paragraph, Second Sentence Comment

The report never discusses the probability that irrigation water is the source of the soil metals concentrations observed at each sample site.

> Response: At those sites that had samples taken above and below irrigation ditches, the differences in metals concentration may be due to historical use of irrigation water. At those sites that had tailings present or were in the flood plain, no partitioning of the contamination is possible.

Second Paragraph, Third, Fourth, and Fifth Sentences Comments

In spite of this omission, the report leaps to the conclusion that "The data suggests that approximately 5,400 acres of land have been affected by the use of these waters for irrigation." This conclusion is allegedly based on an analysis of aerial photographs, but there is no discussion of samples that support a conclusion for over 8 mi^2. Thus, the agriculture investigation report largely contains data and analyses that do not relate to the objective or conclusions of the report.

Response: The 5,400 acre estimate was based initially on a literature review of potentially affected, irrigated sites, followed by sampling of several of these sites within the study area. The conclusion was not based solely on aerial photographs. The sampling, out of necessity, was not exhaustive. Since MultiTech's objective was to determine potentially affected cropland, whatever the source of heavy metals, the data for the agriculture investigation relate to the objective and conclusions of the report. MultiTech, however, should have explicitly stated other potential sources of contaminants on a site by site basis.

Third Paragraph Comment

On page 6-12 reference is made that clearly affected lands could possibly increase several-fold to 18,600 ac. This estimate was not discussed in the remedial investigation report and is totally unsubstantiated. Supporting data should have been presented in the remedial investigation.

Response: The 18,600 acre estimate is mentioned in the RI report but it is not discussed. MultiTech's source (Schafer 1985) for the estimate is a memorandum from Bill Schafer to Ken Knudsen and Mike Rubich regarding potential impacts of irrigated land contamination.

SPECIFIC COMMENTS

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: No response is necessary.

CHAPTER 7.0 FAUNA (MACROINVERTEBRATES)

General Comments

MultiTech states (p.ES-13) that "high density and biomass levels, but low diversity communities of organic matter-tolerant caddis flies (especially Cheumatopsyche sp. and Hydropsyche sp.) plus dipterans (Simulium sp.) exist immediately downstream from the Warm Springs Ponds discharge into the Clark Fork River." The phrase "organic matter-tolerant" implies that the caddis fly and true fly communities are capable of enduring the environmental insult of a stream laden with a high degree of organic material. This phrasing contrasts with the findings of the Macroinvertebrate Investigation (p. 3-12 in Appendix E, Part 1, of the RI Summary Report) where it was concluded that: 1) stations below the Warm Springs Ponds were dominated by filter-feeding caddis flies and true flies; and 2) high abundances of filter-feeding insects were attributable to the high productivity of the Warm Springs Ponds. Based on the information provided in the Macroinvertebrate Investigation, it would seem that the term "opportunistic" would better describe the filter-feeding insect communities below Warm Springs Ponds.

The conclusion that insect communities below Warm Springs Ponds exhibit low diversity is based on the assumption that Shannon-Weiner diversity of unpolluted aquatic insect communities ranges from 2.6 to 4.0. This assumption is at best a generalization based on a wide range of aquatic habitats. The extent to which this generalization applies to site-specific conditions below Warm Springs Ponds and in the upper Clark Fork River is not known, and should be discussed in detail if it is going to be the basis for assessing impacts. MultiTech should consider the range of diversity values that is expected for aquatic insect communities that exist in stream sections below other impoundments that are used, for example, in flood control or power generation.

For the years 1980 to 1984, average diversity values for the Clark Fork River stations below Warm Springs Creek ranged from 2.7 to 3.1. Also, for the years 1980 to 1984, abundances, numbers of taxa, and biomass in the

Clark Fork River between Warm Springs Ponds and Deer Lodge overlapped considerably with those for the reference station on Mill-Willow Creek. Abundances, numbers of taxa, and biomass at the Clark Fork station below the Little Blackfoot River were considerably less than those at Mill-Willow Creek in 1980, but were within the range of values for Mill-Willow Creek in subsequent years. Thus, given the enormous interannual and spatial variability in benthic community data, it is likely that few, if any, differences between the Clark Fork River stations and the Mill-Willow Creek reference area would be significant if appropriate statistical analyses were performed. Thus, it could be argued that impacts on the aquatic insect communities in the Clark Fork River are marginal, if they exist at all.

The conclusion that benthic invertebrate recovery in the Clark Fork River may be retarded by trace metal concentrations is based on Phillips' (1985) hypothesis that decreasing trout abundances downstream from Warm Springs Ponds are associated with increasing trace metal concentrations. Given the wide range of variables that may affect trout distribution patterns, and which need to be documented to assess trace metal toxicity, any extrapolation from existing hypothetical impacts on trout communities to retarded recovery of insect communities is extremely speculative and highly premature. The speculative nature of this extrapolation is particularly evident in light of the fact that depressed brown trout abundances occur in the reach between Flint Creek and Rock Creek, which is approximately 20 mi downstream from the benthic community study area.

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

Response: Comments contained on these pages are generally similar to AMC's comments on Appendix E, Part 1. Responses to these comments are contained in Appendix E, Part 1 responses.

CHAPTER 7.1 FAUNA (BIOASSAY)

General Comments

MultiTech states (p.ES-13) that "the RI provided two lines of evidence that fish, particularly rainbow trout (*Salmo gairdneri*), are receptors of heavy metal contaminants present within (and downstream of) the study area." The areas of investigation were toxicity bioassays, and fish tissue bioaccumulation. Toxicity testing of various life-stages of rainbow trout yielded negative results, with water collected under low flow conditions, but it was hypothesized that toxic effects would have been evident under higher stream discharge conditions. Although the validity of this hypothesis remains to be tested, it should also be recognized that the negative bioassay results indicate that significantly toxic conditions may not exist under low flow conditions, even though water quality criteria are exceeded sporadically during local rain events and transient increases in river discharge rates. Comments on the summary of the fish bioaccumulation study are provided below (see Fish Tissue Investigation Section).

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments sections were extensive and preclude meaningful page-by-page comments.

Response: The thrust of the comment contained on these two pages is similar to that contained on page 70 of AMC's comments on Appendix E, Part 2. Response to this comment is contained in Appendix E, Part 2 Response.

CHAPTER 7.2 FAUNA (FISH TISSUE)

General Comments

According to MultiTech (p. ES-13), results of the fish tissue investigation "indicate bioaccumulation of copper and zinc (relative to their respective concentrations in water) in both muscle and liver, while cadmium appeared to be accumulating in the liver only". MultiTech also indicates that, with the exception of copper concentrations in livers, tissue concentrations of the various trace metals were within the range of naturally occurring background concentrations for these substances. Copper concentrations in rainbow trout livers were approximately an order of magnitude greater than those observed in trout collected in Rock Creek by Van Meter (1974). The significance of this finding with respect to biological impacts should be discussed by MultiTech.

The summary of trace metal bioaccumulation in the RI Summary Report focuses on comparisons of trace metals concentrations in fillets and livers with those in water. These sorts of comparisons are not meaningful, especially for essential trace elements such as copper and zinc, and should be qualified in the context of fundamental understanding of physiological mechanisms of trace metal accumulation and regulation.

Bioaccumulation of trace metals is a fundamental biological process that occurs in most, if not all, aquatic organisms, and is functionally necessary for the acquisition and regulation of essential trace elements such as copper and zinc. Since measurable quantities of trace metals have been observed in water from Warm Springs Ponds, it is reasonable and logical to assume that trace metal bioaccumulation occurs to some extent in fishes from Warm Springs Ponds. Thus, whether tissue concentrations exceeded water concentrations of trace metals is largely irrelevant to judging physiological impacts. The major relevant questions should concern whether tissue concentrations of both essential and nonessential trace metals are high enough to pose a toxiocological threat to the survival and fitness of trout. These questions can be addressed by:

- o Comparing measured tissue concentrations with those concentrations that are known to cause disease or functional impairment

- o Comparing measured tissue concentrations with those in background populations where excess exposure to anthropogenic trace metals has not occurred or is minimal.

Cadmium, copper, and zinc were more highly accumulated in livers than in fillets. This finding was phrased in the sense that differential accumulation of trace metals among various tissues is a characteristic pattern of polluted areas, and a noteworthy feature of trace metal bioaccumulation in Warm Springs Ponds trout. However, the high accumulation of cadmium, copper and zinc in liver tissue in comparison with fillets is not an unusual feature, and is probably related to the role of the liver as a key site of metallothionein enzyme activity in fishes (Jenkins et al. 1982).

MultiTech emphasizes the relative differences among tissue concentrations of the various trace metals, but offers little interpretation or discussion of the relevance of these findings. As indicated in this review, the higher concentrations of copper and zinc in comparison to arsenic and cadmium are consistent with environmental concentrations of these substances, and physiological mechanisms for the transport and regulation of essential and nonessential trace metals. Thus, the single unresolved issue is whether the elevated concentrations of copper in liver in comparison with background levels is indicative of functional impairment of rainbow trout in Warm Springs Ponds.

Tissue concentrations of PCBs were approximately an order of magnitude greater than those of PCP. Differences between PCP and PCB concentrations in tissues could not be related to environmental concentrations of these substances because of a lack of site-specific information. Consequently, consideration should be given to the adequacy of the study design and results in determination of whether any meaningful conclusions can be drawn from these data.

Finally, MultiTech indicates that trace metal and organic contaminant concentrations in rainbow trout tissues were generally within the range of background concentrations, and pose minimal public health risks. These conclusions are reasonable.

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

> Response: Comments on the fish tissue investigation on these pages are similar to those presented by the AMC on Appendix E, Part 3. Responses to these comments are contained in Appendix E, Part 3 responses.

CHAPTER 7.3 (WATERFOWL)

Wildlife Populations Using the Site--

Apart from very brief comments on the types of animals present on the site, the tissue analyses for waterfowl using Warm Springs Ponds (Waterfowl Investigation Report, Appendix E, Part 4) constitute virtually all of the data presented concerning wildlife. The discussion of terrestrial fauna presented on pages 1-25 through 1-27 is inadequate. MultiTech does not cite standard references on Montana birds, such as Skaar (1980), and mammals, such as Hoffmann and Pattie (1968). The information on wildlife presented in Chapter 8 for various areas of the site is sketchy, and the sources of the observations are not referenced.

Exposure of Wildlife to Contaminants--

Waterfowl--A summary of the Waterfowl Investigation Report (Appendix E, Part 4) is presented in Section 7.4 (pp. 7-17 through 7-24). The stated purpose of the waterfowl investigation was to provide data for assessing the human health risk of consuming waterfowl from Warm Springs Ponds and for assessing the migration of contaminants into the biota using the site (p. 7-19). Detailed comments on the Waterfowl Investigation Report are provided in the comments on Appendix E, Part 4.

A number of problems with the design of the waterfowl investigation, sampling procedures, and methods of data analysis limit the validity of the findings of the waterfowl investigation and the conclusions drawn from these findings:

- Insufficient sampling was done in control areas, and no data were presented that would allow an evaluation of the appropriateness of chosen control areas as reference areas.

- Tissue concentrations of metals were determined for a variety of species from Warm Springs Ponds but only one species from the control areas, introducing a source of uncontrolled variability into the comparisons.

- Sampling was not performed at the same time of year in Warm Springs Ponds and the control areas, introducing a source of uncontrolled variability into the comparisons.

- Because waterfowl are migratory, they may not be the best species to sample as indicators of exposure to localized environmental contamination. Some individual birds may have spent little time in the area of interest.

- There was no quality control and chain-of custody for sampling, which may have invalidated the results of some tissue analyses.

- o Statistical analyses were incorrectly done, and conclusions of statistically significant differences between groups (e.g., between Warm Springs Ponds and the control areas, or between muscle and liver tissues) are of questionable validity.

- o A major problem arises with MultiTech's failure to adequately define relevant "background" tissue concentrations of contaminants with which to compare tissue concentrations of Warm Springs Ponds waterfowl.

Other Wildlife-- On page 1-26, MultiTech states that deer and elk use some floodplain areas of the site, but provide no indication of the potential for these animals being exposed to contaminants in food plants or water. On page 7-17, it is stated that "big game use of contaminated areas ... is limited," but no data are provided to substantiate this conclusion. MultiTech also does not mention whether or not any game animals, such as deer, elk, or upland game birds, feed in the agricultural areas.

Threatened and Endangered Wildlife Species--Inadequate attention is given to threatened and endangered species. MultiTech indicates on page 1-27 that the Bald Eagle (Haliaeetus leucocephalus) uses the Warm Springs Ponds for foraging, but there is no further mention of potential exposure of these eagles to contaminants in their prey animals. The Bald Eagle is listed as an endangered species by the U.S. Fish and Wildlife Service (1986). MultiTech does not discuss whether any other wildlife species using the site are listed as threatened or endangered by either federal or state agencies.

Effects of Contaminants on Wildlife--

On page 7-1, MultiTech states that "waterfowl collected from the [Warm Springs] ponds' area showed minimal effects," but does not discuss what kinds of effects these may be. There is no discussion in the RI Summary Report of the potential ecological or physiological effects of the

reported concentrations of any contaminant of concern in the tissues of waterfowl, or the potential effects of these contaminants on mammals, other birds, amphibians, or reptiles. Because exposure criteria such as the U.S. Environmental Protection Agency (EPA) criteria for exposure of aquatic life to environmental contaminants are not available for wildlife, a discussion of potential effects from contaminants of concern would be appropriate.

Human Health Concerns Related to Consumption of Game Animals--

MultiTech states in Appendix E, Part 4, that a human health evaluation will be performed during the feasibility study that will use data collected in the waterfowl investigation. However, for reasons discussed above, the data may not be of sufficient quality for this purpose.

Specific Comments

Specific page-by-page comments are not provided for this section of the RI report. Major issues concerning overall study objectives, study design, and data interpretation were addressed in the general comments section. Concerns raised in the general comments section were extensive and preclude meaningful page-by-page comments.

> Response: Comments on these pages regarding the waterfowl investigation are similar to comments contained on Appendix E, Part 4. Responses to these comments are contained in Appendix E, Part 4 responses.
>
> Regarding other wildlife and threatened and endangered wildlife species, AMC should conduct the additional studies it feels are necessary to fill any data gaps. Limited use of contaminated areas by wildlife does not mean that wildlife using these areas are not potentially exposed to contaminants. Similarly, bald eagles foraging in the Warm Springs Ponds area could potentially be exposed to contaminants if prey they ingest contains contaminants.

CHAPTER 8.0 NATURE AND EXTENT OF PROBLEMS

GENERAL COMMENTS

First Paragraph Comments

In Chapter 8 the results of the individual investigations are integrated in an evaluation of the nature and extent of contamination and associated environmental problems. It is imperative that statements in Chapter 8 be made clearly, because the conclusions from the overall basis of defining problems. Throughout the chapter (as throughout the RI Summary Report), unqualified adjectives, for which a quantitative basis is not provided, are used too often to describe the nature and extent of contamination. For example, on Page 8-6, line 10, the normal discharge from the Metro Sewage Treatment Plant (STP) is described as being high in phosphorus. High is a relative term. Does it mean that the value exceeds drinking water standards, is elevated above the baseline value, exceeds some other standards, or falls within the range of high on some standard? The use of the term "significant" should also be explained or quantified using statistical means, where possible.

> Response: The use of adjectives such as "high" and "significant" are used throughout the report to represent the opinion of the authors concerning the differences between measurements.

Second Paragraph Comments

The quantitative basis should be provided for all adjectives describing the nature and extent of contamination, or these adjectives should be qualified. Preferably, a standard or a frame of reference should be used to indicate the relative significance of the value (e.g., exceeds the primary drinking water standard of 0.01 mg/L or is three orders of magnitude greater than the baseline value). At a minimum, the value or a range of values should be provided [e.g, high ($\geq$100 mg/L), or range (0.01-0.05 mg/L)]. A good example of an appropriately qualified statement can be found in Section 8.4.1 on page 8-10, first sentence.

Response: See previous comment.

Third Paragraph Comments

The available data are not fully utilized in Chapter 8 to support the identification of contaminant sources. For example, MultiTech stated that the surface water data indicate that nonpoint sources, presumably groundwater, are major sources of metals loading to silver Bow Creek in the reaches between Station SS-02 and SS-03, and between Station SS-05 and SS-09. However, MultiTech did not use existing groundwater data to confirm the conclusion that groundwater inflow is the primary source of metals loadings in these two reaches. The conclusion that groundwater may be an importance source was based on a mass balance analysis of metals loadings across these two sections of the river. Although not mentioned by MultiTech, available groundwater data support this conclusion by providing evidence that groundwater is contaminated in these areas. The RI summary should integrate all information collected during the RI to strengthen the conclusions presented in the report.

Response: AMC correctly indicates that available groundwater data support the interpretation that groundwater inflow is the primary source of metals loading between Stations SS-02 and SS-03 and between SS-05 and SS-07 during baseflow conditions. The text also indicates groundwater is contaminated in these areas (pages 8-4 and 8-6), which supports the assertations of the summary.

Fourth Paragraph Comments

In the eight subsections on "Environmental Effects" in Chapter 8, MultiTech presents observations on wildlife, dominant plants, and aquatic biota in each area. Because the basis for these observations is not presented, their accuracy cannot be evaluated. Presumably the observations were made on various site visits. Without an indication of the timing of observations and the level of effort involved, their usefulness for characterizing the site cannot be determined.

Response: Observations on dominant plant species were made during the Riparian Vegetation mapping effort. Casual wildlife observations were made by all personnel working on the site. Casual aquatic biota observations were made by the surface water sampling crews.
For the purposes of characterizing the site, this level of effort was selected as appropriate given the level of existing information. A proposed wildlife survey of the site was deleted from the RI study by MDHES with concurrence from AMC representatives during the development of the RI study plan.

SPECIFIC COMMENTS

1. Page 8-4, Line 8: The metals of concern should be specifically named.

   Response: These are the same metals listed in the previous sentence.

2. Page 8-6, Line 10: Define and quantify "high".

   Response: The phosphorus concentrations in the sewage treatment plant discharge were greater than those in the receiving water, Silver Bow Creek.

3. Page 8-8, Line 12: What is the reasoning for not sampling groundwater and analyzing for organics at the location?

   Response: Contamination at this site was investigated during the Phase I RI, and additional sampling is recommended in the Phase I RI Report, including sampling of groundwater and organics. The recommendations will be considered in future remedial investigations for the Rocker area.

4. Page 8-17, Line 18: What analysis was performed to illustrate that the 70 years accumulation of sediments would be washed downstream. Some but not all of this accumulation would wash downstream during the flood.

Response: Pond and embankment failure scenarios would have to be modeled using computer software to evaluate how much of the accumulated sediment would be washed downstream. The intent is that if dam failure occurs, the ponds will act as a contaminant source.

4. Page 8-17, line 15: HEC-1 analysis was performed to determine that the 70 years accumulation of sediment would be washed downstream. Some but not all of this accumulation would wash downstream during the flood.

Response: Pond and embankment failure scenarios would have to be modeled using computer software to evaluate how much of the accumulated sediment would be washed downstream. The intent is that if dam failure occurs, the ponds will act as a control and storage